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IDENTIFIERS	Electrical Wiring; *Power Line Technicians

ABSTRACT

This module is the sixth in a series that is designed to help students achieve greater professional and personal success as power line technicians. Each module represents one or more complete units of instruction with components organized into one instructor and one student "package": the instructor's manual and the student workbook. The instructor's manual begins with a profile of training mastery that lists the competencies covered in the curriculum and provides space for recording information about the student's mastery of each objective. Other introductory matter includes information on use of the manual, recommendations for measuring student performance gains, and required criteria for a competency-based education program. The instructor's manual also contains one set per unit of these components: suggested activities, answers to assignment sheets, answers to test, transparency masters, and test. The student workbook contains one set per unit of most or all of these components: objective sheet, information sheets, assignment sheets, and job sheets. The four units in this module are as follows: (1) line patrol, (2) electrical equipment, (3) work procedures (hot line, basket, hot stick), and (4) troubleshooting (secondary). Most units are designed for use in more than one lesson or class period. (YLB)

ED 403 415

Power Line Technician
Second Edition

Module F

Instructor's Manual
Student Workbook

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Power Line Technician

Second Edition

Module F

- Line Patrol
- Electrical Equipment
- Work Procedures (Hot Line, Basket, Hot Stick)
- Troubleshooting (Secondary)

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CIMC

Instructor's Manual

97-012245

Oklahoma Department
Vocational and Technical Educati
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Stillwater, OK 74074-4
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TI10

POWER LINE TECHNICIAN
PROFILE OF TRAINING MASTERY

Instructor _____ Date _____

Program _____

Grade _____ School _____

Name _____ Soc. Sec. No. _____

Address _____ Phone _____

In Case of Emergency, Contact _____

Address _____ Phone _____

Allergies/Disabilities that might require special accommodation for training (please specify) _____

The above information can be used for school records and/or to ensure safety of students. This confidential information is not to be released to employers or the general public.

Date of Enrollment ___-___-___ Total Class Hours _____ Total Hours Absent _____

Date of Withdrawal ___-___-___ Total On-the-Job Training Hours _____ Total Hours Tardy _____

Date of Completion ___-___-___ Total Lab Hours _____

ON-THE-JOB TRAINING/WORK EXPERIENCE

Duration of Employment _____ Job Title _____ Supervisor's Name _____

Address of Employer _____ Phone _____

Duration of Employment _____ Job Title _____ Supervisor's Name _____

Address of Employer _____ Phone _____

Use of This Document

This document can be used to record information about the student and skills mastered. This information is useful in documenting student progress during training and in providing information about the student's qualifications to potential employers and/or for entry into advanced training programs. Instructors using these materials are authorized to reproduce this document as required for use in their training programs.

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SPECIFIC JOB COMPETENCIES

Instructor: As each competency is mastered, place your initials and the date in the blank on the left. This will verify that the student can perform the skill with a minimum of supervision.

MODULE A

Unit 1 – Orientation to REC

Date/Initial

1. Match terms associated with REC orientation to the correct definitions.
2. State the reason for establishing the Rural Electrification Administration.
3. Discuss the importance of rural electric cooperatives.
4. Describe the benefits of rural electric cooperatives to rural America.
5. Select from a list the finance agencies which loan money to rural electric cooperatives.
6. List types of electric utilities.
7. _____

Pretest Score (%) _____

Post Test Score (%) _____

Modified Gains Score (%) _____

Unit 2 – Introduction to Power Line Technician's Training

Date/Initial

1. List responsibilities of a line technician to the community.
2. Select from a list the responsibilities of a line technician to the employer.
3. Select from a list information that is shown on an organizational chart.
4. List departmental functions of a line department.
5. Select from a list topics taught in this course.
6. List benefits to students who complete the line technician's training course.
7. _____

Pretest Score (%) _____

Post Test Score (%) _____

Modified Gains Score (%) _____

Unit 3 – Job Advancement

Date/Initial

1. Match terms associated with job advancement to the correct definitions.
2. List characteristics employers consider when making promotions.
3. Distinguish between good and poor work attitudes.
4. List steps that will help in job advancement.
5. Select from a list benefits of additional education and training.
6. Discuss activities that will better prepare a person for advancement.
7. Discuss reasons people do not succeed on the job.
8. _____

Pretest Score (%) _____

Post Test Score (%) _____

Modified Gains Score (%) _____

Unit 4 – General Safety

Date/Initial

1. State the safety responsibilities of an REC employee.
2. List the steps of discipline for safety rule violations.
3. Select from a list items which are subject to safety rules.
4. State reasons for the importance of a safety policy.
5. Discuss OSHA regulations for first aid.
6. List the basic steps in first aid.
7. List steps of basic life support.
8. List first aid supplies.
9. List the practices for care of first aid supplies.
10. _____

Pretest Score (%) _____

Post Test Score (%) _____

Modified Gains Score (%) _____

MODULE B

Unit 1 – Personal and Job Safety

Date/Initial

1. Match terms associated with personal and job safety to the correct definitions.
2. Describe the procedures to follow for various types of rescue situations.
3. List components necessary for fire.
4. Match classes of fires to the correct description of each.
5. Match types of fire extinguisher to the class or classes of fire each is best suited to extinguish.
6. List general safety precautions to observe during rescue.
7. Discuss in a short paragraph driving skills needed by a line technician.
8. List some poor attitudes that may cause accidents.
9. Select from a list requirements of a skilled driver.
10. List steps of defensive driving.
11. Identify shapes of traffic signs.
12. Select from a list some general safety precautions to observe when operating equipment.
13. State OSHA/DOT regulations for inspection of equipment.
14. Select from a list the items which should be inspected daily on mechanical equipment.
15. List methods for maintaining a clean and orderly work area.
16. Explain how to lift heavy objects.
17. Describe in a short paragraph the importance of safety communications.
18. Select from a list those items of importance that should be reported to the supervisor.
19. Select from a list items related to safety that a line technician should know concerning location and voltage.
20. State factors which determine the maximum weight which can be lifted by equipment.
21. Determine maximum weight that can be lifted by equipment at various angles.
22. Complete a safety pledge form.
23. _____

Pretest Score (%) _____

Post Test Score (%) _____

Modified Gains Score (%) _____

Unit 2 – Communications

Date/Initial

1. List types of communications necessary for an REC employee.
2. Select from a list those items of communication that are important between fellow workers.
3. List items of communication that are important between the worker and the supervisor.
4. Select from a list those items of communication that are important between the worker and the general public.
5. Identify hoist signals.
6. Identify winch line signals.
7. Identify hand signals used in boom operations.
8. Identify hand signals used when maneuvering vehicles.
9. Identify line work signals.
10. Select from a list the proper radio procedures.
11. State emergency radio procedure.
12. Select from a list the prohibited uses of the radio.
13. Match radio code signal numbers to the correct meanings.
14. List factors that are important when using cellular mobile telephones.
15. _____

Pretest Score (%) _____

Post Test Score (%) _____

Modified Gains Score (%) _____

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Student ratings on specific competencies evaluated during the course are available upon student's written request and/or by calling the instructor. Parent's or guardian's signature is necessary if student is under 18 years of age.

Date/Initial

Unit 3 – Basic Electrical Theory

1. Match terms associated with basic electrical theory to the correct definitions.
2. List uses of electricity.
3. Discuss the electron theory.
4. Distinguish between alternating and direct current.
5. Match types of magnets to the correct descriptions.
6. State the law of magnetic poles.
7. Describe magnetic force as it relates to production of electricity.
8. Select from a list characteristics of electromagnetic force.
9. Explain the generation of electricity using magnets.
10. Describe electromagnetic induction.
11. Identify types of circuits.
12. Identify conditions of circuits.
13. Name sources of alternating and direct current.
14. Identify divisions of an electrical system.
15. State the relationship among amperage, resistance, and voltage.
16. Solve problems using Ohm's law.
17. Calculate for an unknown voltage.
18. Calculate for an unknown amperage.
19. Calculate for an unknown resistance.
20. _____

Pretest Score (%) _____

Post Test Score (%) _____

Modified Gains Score (%) _____

Date/Initial

Unit 4 – Rope and Rigging

1. Match terms associated with rope and rigging to the correct definitions.
2. Identify parts of a stationary block.
3. List kinds of rope used in line work.
4. Determine the tensile strength of various kinds and sizes of rope.
5. Determine the mechanical advantage of using block and tackle.
6. List uses of various types of rope gear.
7. Apply the formula necessary for the safe working load of various kinds and sizes of ropes when given the tensile strength and safety factory.
8. Identify various knots and hitches.
9. Match various knots and hitches with the correct uses.
10. Identify elements of knots, bends, and hitches.
11. List conditions that damage rope.
12. Calculate the mechanical advantage of using block and tackle.
13. Calculate working load of various ropes.
14. _____

Pretest Score (%) _____

Post Test Score (%) _____

Modified Gains Score (%) _____

Date/Initial

Unit 5 – Overhead Construction

1. Match terms associated with overhead construction to the correct definitions.
2. Match materials commonly used in overhead construction to their specific uses.
3. Identify hand tools commonly used in overhead construction.
4. Match hand tools to their specific uses.
5. Identify overhead construction tools.
6. Match overhead construction tools to their specific uses.
7. List elements of overhead construction.
8. List equipment used in overhead construction.
9. Match equipment commonly used in overhead construction to their specific uses.
10. Select from a chart the correct depth to set poles of varying lengths.
11. List methods used to properly sag conductors.
12. Identify various types of connectors used in overhead construction.
13. Match types of construction to the correct descriptions.
14. List steps to properly install a pole key.
15. State correct procedure for installing a ground rod.
16. Arrange in order the steps to follow when framing a pole.
17. Identify various structures used in transmission line construction.
18. _____

Pretest Score (%) _____

Post Test Score (%) _____

Modified Gains Score (%) _____

Date/Initial

Unit 6 – Underground Distribution Construction

1. Match terms associated with underground construction to the correct definitions.
2. Identify equipment used in underground construction.
3. Match various types of equipment to the specific uses.
4. List general requirements for underground construction.
5. Arrange in order the correct procedure for installing cable.
6. List precautions to observe when handling underground cable.
7. Select from a list methods of marking cable for identification.
8. List methods used to locate and identify a utility ditch.
9. Identify equipment used to terminate primary cable on a pole.
10. State the requirement for grounding underground equipment.
11. List hazards which may be encountered in underground construction.
12. List precautions to observe when splicing or terminating cable.
13. Select from a list the tools used in underground construction.
14. Make a proper splice in secondary cable.
15. Make a proper splice in primary cable.
16. _____

Pretest Score (%) _____

Post Test Score (%) _____

Modified Gains Score (%) _____

Date/Initial

Unit 7 – Personal Climbing Tools and Equipment

1. Match terms associated to personal climbing tools and equipment to the correct definitions.
2. Identify personal climbing tools and equipment.
3. Match tools and equipment to the specific use.
4. List conditions to watch for when inspecting personal climbing tools and equipment.
5. Name types of maintenance for personal climbing tools and equipment.
6. List safety precautions to observe when climbing poles.
7. Select from a list the general procedure for climbing poles.
8. Name rules for safe and proper storage of personal tools and equipment.
9. Climb poles.
10. _____

Pretest Score (%) _____

Post Test Score (%) _____

Modified Gains Score (%) _____

Date/Initial

Unit 8 – Right-Of-Way

1. Match terms associated with right-of-way clearing and control to the correct definitions.
2. List methods to maintain good public relations.
3. Identify tools used for right-of-way clearing and control.
4. State the purposes of right-of-way control.
5. Select from a list the safe working procedures for right-of-way clearing and control.
6. Select proper methods of tree trimming.
7. List steps to remove limb hanging over an energized conductor.
8. List steps to fell a tree.
9. State the specifications for clearing right-of-way for distribution line.
10. List types of clearing and chemical control for right-of-way.
11. Identify various trees that grow rapidly.
12. Identify poisonous vegetation.
13. Draw cuts needed to remove heavy limbs.
14. Draw procedure for removing limb hanging over energized conductor.
15. Draw procedure for felling a tree.
16. _____

Pretest Score (%) _____

Post Test Score (%) _____

Modified Gains Score (%) _____

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Date/Initial

Unit 9 – Distribution Transformers

1. Match terms associated with transformers to the correct definitions.
2. State the functions of a transformer.
3. Identify parts of a completely protected transformer.
4. Distinguish between additive and subtractive polarity as they relate to transformers.
5. List kinds of transformers.
6. Match types of transformers to the correct descriptions.
7. Classify types of transformers as oil-cooled or air-cooled.
8. Discuss technical considerations in protective grounding and jumpering.
9. List information found on a transformer nameplate.
10. _____

Pretest Score (%) _____

Post Test Score (%) _____

Modified Gains Score (%) _____

MODULE C

Date/Initial

Unit 1 – Poles

1. Match terms associated with poles to the correct definitions.
2. List five types of preservatives used on poles.
3. Match the type of preservatives used on poles with their code letters.
4. Select from a table the classes of poles of varying lengths and circumferences.
5. Select from a list precautions to observe when handling poles.
6. Calculate the weights of various classes and lengths of commonly used poles using a table.
7. List methods used to set poles.
8. State the correct procedure for checking a pole before climbing.
9. Arrange in proper order the steps for pole inspection.
10. List methods used to support unsafe poles for climbing.
11. State the correct method for storing poles.
12. Select from a table the classes of poles of varying lengths and circumferences.
13. Calculate the weights of various classes and lengths of commonly used poles using a table.
14. _____

Pretest Score (%) _____

Post Test Score (%) _____

Modified Gains Score (%) _____

Date/Initial

Unit 2 – Conductors

1. Match terms associated with line conductors to the correct definitions.
2. List methods used to protect line conductor at supports.
3. Arrange in order the steps to follow when joining ACSR conductors.
4. Arrange in order the steps to follow when joining CWC conductors.
5. List classes of conductors.
6. List methods of reeling our conductor.
7. Identify various types of conductor ties.
8. Match types of conductors to their specific use.
9. State conductor clearance from ground, roofs and building walls for conductors carrying 750 volts or less.
10. State conductor clearance from ground for conductors carrying over 750 volts to 22,000 volts.
11. Match current-carrying capacities of various ACSR conductors to the correct conductor size.
12. Match current-carrying capacities of various copperweld copper conductors to the correct conductor size.
13. Install a preformed line tie on ACSR conductor on a de-energized circuit.
14. Install a top groove conductor tie on a de-energized copper conductor.
15. Install a preformed armor rod on ACSR conductor.
16. Join ACSR conductor.
17. _____

Pretest Score (%) _____

Post Test Score (%) _____

Modified Gains Score (%) _____

Date/Initial

Unit 3 – Grounding and Connecting

1. Match terms associated with grounds and connectors to the correct definitions.
2. State the purposes of grounding.
3. List methods of grounding.
4. Select from a list those elements necessary for good grounding.
5. Select from a list equipment which must be grounded.
6. State the correct procedure for installing temporary protective grounds.
7. Arrange in order the steps to follow when disconnecting and grounding at sectionalizer or recloser station.
8. Arrange in order the steps to follow when disconnecting and grounding at multiphase vertical corner.
9. State the procedure for installing temporary protective grounds at air-break switch on a transmission line.
10. List elements of a good connection.
11. _____

Pretest Score (%) _____

Post Test Score (%) _____

Modified Gains Score (%) _____

Date/Initial

Unit 4 – Generators and Batteries

1. Match terms associated with generators and batteries to the correct definitions.
2. List kinds of generating plants.
3. Match kinds of generators to the voltages produced by each.
4. Match kinds of generators to the specific uses.
5. Calculate the frequency (Hertz) of various generators.
6. List precautions to observe with the use of portable generators.
7. List types and kinds of voltage-producing cells.
8. Identify various circuits of connected batteries.
9. Select from a list precautions to observe when connecting batteries.
10. Arrange in order the steps to follow to connect lead-acid batteries when starting equipment.
11. Connect batteries in series and parallel.
12. _____

Pretest Score (%) _____

Post Test Score (%) _____

Modified Gains Score (%) _____

Date/Initial

Unit 5 – Work Procedures (Nonenergized)

1. Match terms associated with work procedures to the correct definitions.
2. Select from a list information found on a staking sheet.
3. Arrange in proper order the procedure for line construction.
4. List steps to follow when installing service wire.
5. State the procedure for connecting service wire.
6. Match the materials needed to construct primary and neutral assemblies using ACSR conductor 7.2kV construction.
7. List materials needed to install various pole ground assemblies.
8. List materials needed for various primary assemblies.
9. List materials needed to complete a work order.
10. Identify section numbers within a township.
11. Locate rural property in Oklahoma using legal descriptions.
12. _____

Pretest Score (%) _____

Post Test Score (%) _____

Modified Gains Score (%) _____

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MODULE D

Date/Initial

Unit 1 – Insulation

1. Match terms commonly associated with insulators and insulation to their correct definitions.
2. List steps to follow when installing a pin type insulator.
3. Select from a list methods of insulating distribution voltages.
4. Select from a list methods of insulating various transmission voltages on wooden structures.
5. Match insulative materials to their specific uses.
6. Select from a list precautions to observe with insulators and insulation.
7. _____

Pretest Score (%) _____

Post Test Score (%) _____

Modified Gains Score (%) _____

Date/Initial

Unit 2 – Substations

1. Match terms commonly used with substations to the correct definitions.
2. State functions of a substation.
3. Identify components of a substation.
4. Match components of a substation to their specific use.
5. Arrange in order the steps for taking a substation out of service.
6. Select from a list precautions to observe with a substation.
7. Arrange in order the correct procedure for changing a substation oil circuit recloser.
8. State the correct procedure for bypassing a substation current transformer.
9. List indications in a substation that could cause an outage.
10. Match indications to problems which may occur in substations.
11. _____

Pretest Score (%) _____

Post Test Score (%) _____

Modified Gains Score (%) _____

Date/Initial

Unit 3 – Ground and Jumpers (Line Equipment)

1. Match terms commonly used with grounds and jumpers to the correct definitions.
2. Match types of jumpers to their specific use.
3. State requirements for various jumpers.
4. Select from a list the line equipment that is connected by jumpers.
5. Match types of jumpers to the correct installation methods.
6. State the requirements for safe grounding of line equipment.
7. Distinguish between proper and improper grounding methods.
8. Calculate current flow of faulted equipment which is improperly grounded.
9. Calculate voltage on improperly grounded faulted equipment.
10. _____

Pretest Score (%) _____

Post Test Score (%) _____

Modified Gains Score (%) _____

Date/Initial

Unit 4 – Voltage and Current Measuring

1. Match terms commonly used with voltage and current measurements to the correct definitions.
2. State the purposes of voltage and current measurements.
3. Identify equipment used for voltage and current measurements.
4. State the correct procedure for determining voltage drop of a service.
5. State the correct procedure for determining current demand on a primary circuit in a specific area.
6. State procedures for determining current demand on a transformer.
7. List steps to obtain primary line voltage drop.
8. Select from a list reasons for current measurements.
9. Match full load secondary current at 240 volts single phase to the kVA ratings of a transformer.
10. Select from a list precautions to observe when making voltage and current measurements.
11. _____

Pretest Score (%) _____

Post Test Score (%) _____

Modified Gains Score (%) _____

MODULE E

Date/Initial

Unit 1 – Meters and Meter Application

1. Match terms commonly associated with metering to the correct definitions.
2. List general types of meters.
3. List types of meters by base construction.
4. List classes of meters and the current-carrying capacity of each.
5. Match meters to types of service.
6. Match meter to voltage ratings to types of service.
7. Match abbreviations and symbols used with metering circuit diagrams to the correct meanings.
8. List uses of current transformer metering.
9. List uses of self-contained meter connections.
10. Identify various self-contained meter connections.
11. Identify various transformer-rated meter connections.
12. Identify various transformer-rated meter connections for 600 volts or above.
13. State the procedure for selecting the correct meter.
14. List methods for determining voltage for wye and delta connected meters.
15. Match types of services to specific uses.
16. List types of meters which have multipliers.
17. Arrange in order the correct procedure for determining meter multipliers.
18. List precautions to observe with metering.
19. Calculate the multiplier for a transformer-rated meter connected to a secondary line.
20. Calculate the multiplier for a transformer-rated meter connected to a primary line.
21. _____

Pretest Score (%) _____

Post Test Score (%) _____

Modified Gains Score (%) _____

Date/Initial

Unit 2 – System Knowledge

1. Match terms used with system knowledge to the correct definitions.
2. Define symbols used with overhead lines and equipment identification on system maps.
3. Define symbols used with underground lines and equipment identification on system maps.
4. Identify symbols used to locate cultural features on system maps.
5. List functions of automated equipment.
6. List precautions to observe with automated equipment.
7. Select from a list conditions associated with system terrain.
8. Identify symbols on a system map.
9. _____

Pretest Score (%) _____

Post Test Score (%) _____

Modified Gains Score (%) _____

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Date/Initial

Unit 3 – Transformer Connections and Banking

1. Match terms commonly used with transformer connections and banking to the correct definitions.
2. Define characteristics of transformer construction.
3. Match symbols used with transformer voltage rating and connection diagrams to the correct meanings.
4. Discuss transformer polarities.
5. Discuss bushing locations in relationship to polarity on padmount transformers and compare to pole-type in regard to subtractive and additive.
6. Identify secondary coil connections for two- and three-wire service.
7. Identify single-transformer connections for three-wire service.
8. Identify two-transformer banks.
9. Define objectives an electrician must keep in mind when constructing three-phase banks.
10. List in order the step-by-step process for designing three-phase banks.
11. Describe phase relationships between the bushings in three-phase banks.
12. Identify types of primary and secondary connections for three-transformer banks.
13. List precautions to observe when selecting transformers to be banked or paralleled.
14. Identify secondary connections on a four-bushing transformer.
15. State the correct method of connecting wye and delta transformers to a primary line.
16. Arrange in order the steps to find a faulted transformer in a bank.
17. State the precautions to observe with transformer banks.
18. Connect transformer secondary coils in series and parallel.
19. Connect a wye-delta bank for three-phase four-wire 120/240-volt service.
20. Connect a wye-delta bank for three-phase three-wire 240-volt service.
21. Connect a wye-wye bank for three-phase four-wire 120/208-volt service.
22. Connect an open-wye open-delta bank for three-phase four-wire 120/240-volt service.
23. Connect an open-wye open-delta bank for three-phase three-wire 240-volt service.
24. Connect an open-delta open-delta bank for three-phase four-wire 120/240-volt service.
25. Connect two single-bushing transformers in parallel.
26. _____

Pretest Score (%) _____

Post Test Score (%) _____

Modified Gains Score (%) _____

Date/Initial

Unit 4 – Phasing

1. Match the terms commonly associated with phasing to the correct definitions.
2. List elements of phasing.
3. State methods of determining phase rotation.
4. State the procedure for changing the direction of rotation of a three-phase motor.
5. Arrange in order the steps to follow when phasing circuits with a phasing meter.
6. Arrange in order the steps to follow to identify distribution phases.
7. Label substation distribution phases.
8. _____

Pretest Score (%) _____

Post Test Score (%) _____

Modified Gains Score (%) _____

MODULE F

Date/Initial

Unit 1 – Line Patrol

1. Match types of line patrol to the specific purpose.
2. Select from a list items to observe when patrolling line.
3. Match items to the specific conditions to observe when patrolling a line.
4. List methods of line patrol.
5. Select from a list requirements of a line patroller.
6. List items to observe with line equipment.
7. Complete a line inspection form.
8. _____

Pretest Score (%) _____

Post Test Score (%) _____

Modified Gains Score (%) _____

Date/Initial

Unit 2 – Electrical Equipment

1. Match terms used with electrical equipment to the correct definitions.
2. Match electrical equipment to the specific uses.
3. Arrange in order the steps to follow when connecting a voltage regulator to a three-phase line.
4. Arrange in order the steps to follow when placing a voltage regulator in service.
5. State the procedure for setting voltage regulator time delays.
6. State the procedure for taking a voltage regulator out of service.
7. List precautions to observe with voltage regulators.
8. List precautions to observe with capacitors.
9. Select from a list the benefits of capacitor application.
10. Name equipment that should be protected by lightning arresters.
11. Explain the method of coordinating reclosers with other reclosers.
12. List precautions to observe when installing sectionalizers.
13. Select from a list factors to consider when coordinating reclosers and fuses.
14. Connect voltage regulators to a three-phase line.
15. _____

Pretest Score (%) _____

Post Test Score (%) _____

Modified Gains Score (%) _____

Date/Initial

Unit 3 – Work Procedures (Hot Line, Basket, Hot Stick)

1. List methods of hot line maintenance.
2. Select from a list OSHA requirements for aerial devices.
3. Select from a list rules to observe when working with aerial devices.
4. List elements of hot line maintenance.
5. State the procedure for hot line maintenance from an aerial device.
6. Arrange in order the steps to follow when changing a pole top insulator from a basket.
7. Match various hot line tools to their specific uses.
8. Install a wire tong saddle.
9. Change an insulator on an energized conductor using hot line tools on an A1 structure.
10. _____

Pretest Score (%) _____

Post Test Score (%) _____

Modified Gains Score (%) _____

Date/Initial

Unit 4 – Troubleshooting (Secondary)

1. Match terms associated with troubleshooting to the correct definitions.
2. Match indications of malfunctions to the possible causes.
3. Arrange in order the correct procedure for troubleshooting electrical equipment.
4. List precautions to observe when troubleshooting electrical equipment.
5. Select from a list items of information to obtain while troubleshooting.
6. _____

Pretest Score (%) _____

Post Test Score (%) _____

Modified Gains Score (%) _____

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MODULE G

Date/Initial

Unit 1 – Troubleshooting (Primary Line)

_____ 1. Match troubleshooting problems to possible causes.
_____ 2. Arrange in order the troubleshooting procedures to follow for various problems.
_____ 3. List precautions to observe when troubleshooting primary lines.
_____ 4. Arrange in order the steps for troubleshooting a primary line outage.
_____ 5. _____

Pretest Score (%) _____

Post Test Score (%) _____

Modified Gains Score (%) _____

Date/Initial

Unit 2 – System Knowledge

_____ 1. List problems associated with line switching.
_____ 2. Arrange in order the steps to follow when switching line.
_____ 3. List factors involved in line switching.
_____ 4. Select from a list precautions to observe with line voltage regulators on a switched line.
_____ 5. List precautions to observe when opening a line switch.
_____ 6. Select from a list areas and locations of importance to the line technician.
_____ 7. _____

Pretest Score (%) _____

Post Test Score (%) _____

Modified Gains Score (%) _____

Date/Initial

Unit 3 – Conversions

_____ 1. List types of conversions.
_____ 2. Arrange in order the steps to convert a primary line to a higher voltage.
_____ 3. Arrange in order the steps to change a substation feed area to a higher voltage.
_____ 4. Explain benefits of converting to a higher voltage.
_____ 5. Select from a list precautions to observe with autotransformers.
_____ 6. Arrange in order the steps to convert a single-phase line to V-phase.
_____ 7. Arrange in order the steps to convert a single-phase line to three-phase.
_____ 8. _____

Pretest Score (%) _____

Post Test Score (%) _____

Modified Gains Score (%) _____

BEST COPY AVAILABLE

Power Line Technician: Module F

Instructor's Manual

Upfront

Suggested Activities

Answers to Assignment Sheets

Answers to Test

Transparency Masters

Test

Developed by the
Curriculum and Instructional Materials Center
Oklahoma Department of Vocational and Technical Education

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Curriculum and Instructional Materials Center

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Instructor's Manual

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One set per unit of the following components:

- Suggested Activities
- Answers to Assignment Sheets
- Answers to Test
- Transparency Masters
- Test

Student Workbook

One set per unit of Objective Sheets, Information Sheets, Assignment Sheets, and Job Sheets for each of the units in this module:

MODULE A

1. Orientation to REC
2. Introduction to Power Line Technician's Training
3. Job Advancement
4. General Safety

MODULE B

1. Personal and Job Safety
2. Communications
3. Basic Electrical Theory
4. Rope and Rigging
5. Overhead Construction
6. Underground Distribution Construction
7. Personal Climbing Tools and Equipment
8. Right-of-Way
9. Distribution Transformers

MODULE C

1. Poles
2. Conductors
3. Grounding and Connecting
4. Generators and Batteries

5. Work Procedures (Nonenergized)

MODULE D

1. Insulation
2. Substations
3. Grounds and Jumpers (Line Equipment)
4. Voltage and Current Measuring

MODULE E

1. Meters and Meter Application
2. System Knowledge
3. Transformer Connections and Banking
4. Phasing

MODULE F

1. Line Patrol
2. Electrical Equipment
3. Work Procedures (Hot Line, Basket, Hot Stick)
4. Troubleshooting (Secondary)

MODULE G

1. Troubleshooting (Primary Line)
2. System Knowledge (Phase II)
3. Conversions

FOREWORD

The *Power Line Technician* series is designed to help students achieve greater professional and personal success. As a tool for building a rewarding career, this series will help students develop their professional competence. In addition, the series provides a foundation for career advancement. The *Power Line Technician* series consists of seven modules which address specific skill areas. Each module represents one or more complete units of instruction with components organized into one student and one instructor "package": the *Student Workbook*, and the *Instructor's Manual*. We believe the format and packaging will facilitate both the delivery and mastery of the identified competencies.

We hope that this series will enhance instruction and contribute to rewarding learning experiences for all students.

Roy Peters, Jr.
State Director
Oklahoma Department of
Vocational and Technical Education

Ivan Armstrong
State Supervisor
Trade and Industrial Education

ACKNOWLEDGMENTS

The Curriculum and Instructional Materials Center (CIMC) extends its appreciation to the individuals who played key roles in the development of this publication. Such a comprehensive effort requires contributions from many people. We sincerely appreciate the support necessary to complete this project.

Design: Special thanks are extended to the representatives from industry, teaching, and vocational education who participated as members of the curriculum advisory committees for the *Power Line Technician* series. We also thank the administrators, supervisors, and others who supported their participation. Significant contributions were made during the revision process by participants from ABB Power T&D Company Inc., the Association of Missouri Electric Cooperatives, the Central Rural Electric Cooperative (Stillwater, Oklahoma) and the City of Stillwater.

Development: The modules in this series were edited by Craig Maile and Dr. Lois Sharpton. Individual modules were formatted by Vonda Gile. Brenna Tillman, Publications Supervisor in the CIMC, assisted in adapting the packaging.

Production: The close cooperation and dedication of professionals at the Oklahoma Department of Vocational and Technical Education were instrumental in producing the *Power Line Technician* series. Unit and cover artwork were designed by the Art Department, under the direction of Bob Davis, Art Manager. This series could not have been printed without the expertise and commitment of the Printing Plant Staff, under the direction of Danny Darrow. Delivering the final product was accomplished through the excellence of the CIMC Customer Service staff and the staff of the CIMC Warehouse, under the direction of Darrell Stiles.

Support: A number of people at the CIMC helped to make this series possible. Terri Tomson efficiently handled the development contracts, committee meetings, and correspondence relating to this series. This project also received generous support from John Friedemann, CIMC Team Leader, and Dr. Lynna Ausburn, Development Coordinator.

Project Management: Dr. Marilyn Troupe and Craig Maile

USE OF THIS PUBLICATION

Each unit of instruction is based on the performance needed for successful employment in an occupational area. A complete unit will contain most or all of the following components: Objective Sheet, Suggested Activities, Information Sheet, Assignment Sheet, Job Sheet, Test, Answers to Assignment Sheets, Answers to Test, and Transparency Masters. These components are organized within two packages, as follows:

Instructor's Manual

- Upfront pages
- One set per unit of:
  - Suggested Activities
  - Answers to Assignment Sheets
  - Answers to Test
  - Transparency Masters
  - Test

Student Workbook

- Objective Sheets
- Information Sheets
- Assignment Sheets
- Job Sheets

Instructor's materials include the *Instructor's Manual* and the *Student Workbook*.

Unit components are tied to measurable and observable learning outcomes. Instructors are encouraged to supplement unit components with other resources to make units as responsive to local conditions and student needs as possible.

Most units of instruction are designed for use in more than one lesson or class period. Instructors should determine the following for each unit:

- amount of material that can be covered in each class period;
- skills that must be demonstrated;
- supplies and equipment needed;
- amount of class time needed for demonstrations;
- amount of class time needed for student practice;
- supplementary materials to be ordered; and
- resource persons who must be contacted.

Objective Sheet (Student Workbook)

The Objective Sheet summarizes each unit for the student and the instructor. The Objective Sheet includes the following sections:

> **Unit Objective** – The Unit Objective states the overall goal of the unit. It identifies what the student will be able to do after successfully completing the unit, as well as the standards used to measure student performance.
>
> **Specific Objectives** – The Specific Objectives outline the teaching sequence of the competencies required to reach the Unit Objective.

The Specific Objectives on the Objective Sheet should be emphasized to all students at the start of each unit and throughout the teaching/learning process. This will help answer student questions about performance requirements for each unit. Specific Objectives can also assist instructors in determining teaching strategies and instructional methods. Instructors should prepare for each unit by deciding how each objective could best be taught.

Instructors should modify, delete, or add objectives to meet the needs of students and the community. When objectives are added, the instructor should remember to provide the needed information, Assignment and/or Job Sheets, and criterion-referenced test items to cover the new objectives.

Information Sheet (Student Workbook)

The Information Sheet provides the "must know" content essential for meeting the cognitive objectives in the unit. The Information Sheet may include clarifying NOTES and EXAMPLES, as needed. Students should read the Information Sheet for each unit before it is discussed in class.

Assignment Sheets (Student Workbook)

The Assignment Sheets address the learning levels at or above the application level of Bloom's taxonomy. They allow students to perform non-psychomotor activities related to occupational tasks. Assignment Sheets also provide students with an opportunity to use higher-order thinking skills, such as problem-solving, synthesizing, analyzing, and evaluating. In addition, they may provide opportunities for cooperative learning and more detailed oral/written communication activities.

Job Sheets (Student Workbook)

Job Sheets give students step-by-step procedures for performing manipulative or psychomotor occupational tasks or jobs. The Job Sheet also facilitates the instructor's evaluation of each student's performance. Both the process and the end-product are evaluated. Diagrams, illustrations, and photographs are included, as needed, to assist students in completing the job.

The instructor should demonstrate the procedure outlined in each Job Sheet. Instructors may also have to localize specific procedures.

Suggested Activities (Instructor's Manual)

Instructors should study the Suggested Activities before introducing the unit, allowing enough time to obtain supplemental materials, prepare audiovisual materials, and contact outside resource persons. Specific tasks of the instructor will vary with each unit.

Answers to Assignment Sheets and Answers to Test (Instructor's Manual)

These components list the answers to all of the Assignment Sheets and the Test questions.

Transparency Masters (Instructor's Manual)

Transparency Masters are provided so that instructors can make transparencies to accompany specific units. Transparencies allow students to *see* as well as hear the information being presented, thus reinforcing the learning process. They also direct attention to the topic under discussion. Transparencies should be left on the screen only when the related topics are under discussion.

Test (Instructor's Manual)

The Test provides criterion-referenced evaluation of the Specific Objectives from the Information Sheet (Assignment Sheet and Job Sheet objectives are not evaluated by the Test). If instructors have added, deleted, or modified any objectives, appropriate changes should be made to the Test as well.

The Test serves as both a pretest and a posttest. In order to measure and document student competency gains as required by the latest Carl Perkins regulations, and as outlined in the Oklahoma-developed system of standards and measures, it is *essential* that the same test be used as a pretest and as a posttest. If instructors choose to use tests other than the unit Test, they should make sure that the same instrument is used for each activity – pre- and posttest.

A detailed explanation of the Oklahoma plan for standards and measures and the Carl Perkins requirements is included in the CIMC publication *Measuring Learning & Competency Gains: The Pretest/Posttest Approach.* This booklet – and accompanying software to assist in calculating and recording student gains – are available to Oklahoma instructors through their school's vocational testing liaison.

Profile of Training Mastery

The Profile of Training Mastery documents student performance. Each profile lists the competencies covered in the curriculum, and provides space for recording information about the student and the student's mastery of each objective. Space is also provided for recording pre- and posttest scores, modified gains, and instructor comments. A blank Profile of Training Mastery is available for this series. It may be reproduced for each student.

Page Numbering

Each Module is identified with a letter (A - G). Each unit and page has a number, shown in Arabic numerals. For example, the page number for Module A, Unit 2, page 3 of the *Student Workbook* would appear as follows:

PLT A - 2 - 3

Methods of Disseminating Material

For best results, provide each student with a copy of the Student Workbook. Students should be allowed to keep their Workbooks at the end of the course or training program.

Teaching Methods

Keeping students motivated is a challenge. Supplement each unit with current information, personal experiences, and other information. In a group setting, prepare for each unit by determining the best way to teach each objective, and allow for student input. For individualized instruction, provide opportunities for the student to become involved in planning and being responsible for his or her own education.

MEASURING STUDENT PERFORMANCE GAINS

Each CIMC unit contains only a single unit Test. This test should be used as **both** pretest and posttest by giving it once before students start a unit and again when they have completed the unit.

The reason for using a single instrument as both pretest and posttest is so that direct comparison of each student's competencies before and after instruction can be made accurately. This comparison enables precise calculation, documentation, and evaluation of student **performance gains**.

Accurate performance gains analysis is an important requirement of the new Carl Perkins legislation for vocational education. Teachers can make an important contribution to the performance accountability mandated by the new federal legislation by carrying out accurate performance gains analysis for their students, and making this data available to students, parents, and administrators.

This analysis is easy to do and requires only simple calculations and record keeping. Detailed information regarding performance gains analysis is contained in the CIMC publication, *Measuring Learning & Competency Gains: The Pretest/Posttest Approach.* In addition, the CIMC has developed a computer program, CARL, which will perform all necessary calculations and will print out a record form of all information required for gain score analysis. Copies of CARL and the publication are available through your local testing liaison (in Oklahoma), or from the CIMC at 1-800-654-4502.

REQUIRED CRITERIA FOR A COMPETENCY-BASED EDUCATION PROGRAM

Criterion	Discussion	CIMC component meeting criterion
1. Instruction is based on clearly-stated learning objectives that are: a) observable and measurable, and b) communicated in writing to students before instruction begins.	Learning objectives drive CBE. Objectives are the "competencies" that learners must achieve. Each objective must clearly state what *learners* must *do* to demonstrate acquired skill or knowledge. Verbs in learning objectives are active and precise, stating the exact performance expected of learners. The objectives should also specify the standard or level of performance required. Objectives can be at any level of Bloom's Taxonomy and can include the cognitive, psychomotor, and affective domains. Higher-order cognitive skills should be included.	Objective Sheet
2. Instruction is aligned with the stated learning objectives.	In CBE, the objectives specify what is taught. "Content" should relate to one or more objectives. The curriculum should cover all objectives with relevant information.	Information Sheet
3. There is a student evaluation system that is: a) criterion-referenced, and b) aligned to the learning objectives and the curriculum.	In CBE, the aim is to bring the performance of *all* learners up to a pre-defined standards and competencies. Learners work on each competency until they achieve "mastery"; the evaluation system should test and record this mastery. Learners can restudy and retest as often as needed. Specific remediation activities should also be available to learners when needed. The evaluation system focuses on what each student has achieved, not on what the instructor has "taught." The "constant" in CBE is student performance; the "variables" are time and resources. (This differs from traditional systems where learners get one chance at mastery; some succeed and some fail. In such systems, time and resources are constant and student achievement is variable.) If an evaluation is criterion-referenced, successful learner performance is defined by (or *referenced* to) mastery of pre-set objectives and standards (or *criteria*): there must be a careful match (or *alignment*) between what the student should master (objectives), what is taught (curriculum), and what is tested. Objectives, curriculum, and evaluation system must all match.	Test and Job Sheet

Criterion	Discussion	CIMC component meeting criterion
4. There is an observable management system of cognitive skill practice that provides for, promotes, and documents mastery learning.	For both cognitive and psychomotor skills, a CBE program must have a system of maintaining records of which skills and activities each learner has completed, which ones are in progress, and which ones have not yet been completed. Completion means "mastery"; no skill is completed until the learner has achieved the mastery level. The record system should promote feedback on student skill attainment to *both* instructor and learners, provide for remediation as needed, and encourage reevaluation of learner performance until mastery is achieved. Appropriate remediation strategies often should consider learning styles and other individual differences among learners. Learners should work on skills and activities until they achieve mastery. They should not be "passed on" without mastery. While learners may move ahead and work on other skills (i.e those for which all prerequisite skills have been mastered or those without prerequisites), work should also continue on the skills still requiring mastery. Students should not attempt higher-order skills until all prerequisite skills are mastered.	Assignment Sheet
5. There is an observable management system of psychomotor skill practice that provides for, promotes, and documents mastery learning.		Job Sheet
6. Skill mastery records are maintained for each learner, and learners have access to and make use of these records to monitor their skill acquisition.	Records should clearly indicate the skills each learner has mastered. One such record should profile or list the competencies that have been mastered and those to be mastered. Other performance indicators can be added and kept in a portfolio for each learner. Learners should have ready access to their portfolios to monitor their own progress in skill mastery and competency attainment.	Profile of Training Mastery

CORRECTIONS AND SUGGESTIONS

The Curriculum and Instructional Materials Center (CIMC) wants to provide vocational instructors and students with accurate and effective materials. Although the CIMC strives to maintain the highest standards of development and production, oversights sometimes do occur. If you find any errors in this or other CIMC publications, or have suggestions for improving their usefulness in vocational programs, please notify the CIMC staff. To do this, please identify the page(s) affected and write any comments to clarify the error or suggestion. Use the spaces below. Then, simply fold (bottom of page *upward*, top *downward*), secure, and mail.

This information will be used to correct the publication before the materials are reprinted. To ensure that the material is updated on a timely basis, notify the CIMC of necessary corrections as soon as possible after discovering the error.

[2] Fold downward

Page: Comment:

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LINE PATROL
UNIT 1

SUGGESTED ACTIVITIES

1. Suggested activities for instructor:

   - Provide student with objective sheet.
   - Provide student with information and assignment sheet.
   - Discuss unit and specific objectives.
   - Discuss information and assignment sheet.
   - Take student to field to inspect line.
   - Give test.

2. Unit reference

   - *Power Line Technician.* Stillwater, OK: Oklahoma Department of Vocational and Technical Education, Curriculum and Instructional Materials Center, 1978.

LINE PATROL
UNIT 1

ASSIGNMENT SHEET ANSWERS

Evaluate student's completed evaluation form.

LINE PATROL
UNIT 1

ANSWERS TO TEST

1. a. 3
   b. 1
   c. 2
   d. 4
2. a, b, c, d, e, f, g, h, i, j, k, m, n, o, p, r, s, t, u, v
3. a. 8 g. 6
   b. 7 h. 2
   c. 1 i. 10
   d. 4 j. 9
   e. 3 k. 5
   f. 11
4. a. Foot
   b. Vehicle
   c. Aircraft
   d. Boat
5. a, b, c, d, f

ANSWERS TO TEST

6. a. Broken, cracked, or chipped bushings

   b. Oil leaks

   c. Temperature indicators

   d. Operation counter

   e. Lightning arrester gaps

7. Evaluated on Assignment Sheet 1.

LINE PATROL
UNIT 1

TEST

NAME _____ SCORE _____

1. Match types of line patrol on the right to the specific purpose.

_____a.	Compile detailed information on an existing line for a line change such as a line move, a rebuild, or reconductoring	1.	Regular
_____b.	Examine and report the condition of each pole, insulator, and conductor and all right-of-ways	2.	Follow-up
_____c.	Determine the cause of a problem such as blinking lights or breaker operations	3.	Special
_____d.	Locate a fault of problem without delay to restore service or to prevent an outage	4.	Emergency

2. Select from a list items to observe when patrolling a line. Place an "X" in front of the correct items.

_____a. Conductors

_____b. Guys

_____c. Woodpecker holes

_____d. Poles

_____e. Foreign objects on poles

_____f. Crossarms

_____g. Insulators

_____h. Trees

_____i. Line equipment

_____j. Kites or kite string

_____k. Ground wires

_____l. Mobile equipment

TEST

_____m. Crossings

_____n. Washes near poles

_____o. Radio interference

_____p. Sag

_____q. Wildlife

_____r. Jumpers

_____s. Hardware

_____t. Tie wires

_____u. Clearances

_____v. Construction near line

3. Match items on the right to the specific conditions to observe when patrolling a line.

_____a. Cracks, chips or blackening

_____b. Leaning, washed out, or graded out

_____c. Broken anchor rod or stretched conductor

_____d. Loose connector at neutral or stapes not driven into pole

_____e. Burned spots; broken or frayed strands

_____f. Loose nuts, washers, or connectors

_____g. Near enough to blow into conductor or break off and fall onto conductor

_____h. Cracks, splits or loose hardware

_____i. Slack enough to blow into pole or equipment

_____j. Insufficient separation of conductors

_____k. Insufficient clearance over roads or from other utilities

1. Guys
2. Crossarms
3. Conductors
4. Ground wires
5. Crossings
6. Trees
7. Poles
8. Insulators
9. Sag
10. Jumpers
11. Hardware

May be photocopied for student use.

TEST

4. List methods of line patrol.

   a. _____

   b. _____

   c. _____

   d. _____

5. Select from a list requirements of a line patroller. Place an "X" in front of the correct requirements.

   _____a. Make a written report of the line conditions observed

   _____b. Follow up on reported conditions to see that repairs are made

   _____c. Observe all parts of line being patrolled

   _____d. Distinguish between hazardous and nonhazardous conditions

   _____e. Make a routine voltage check along the line

   _____f. Make a list of materials and equipment needed to make repairs

6. List items to observe with line equipment.

   a. _____

   b. _____

   c. _____

   d. _____

   e. _____

7. Evaluated on Assignment Sheet 1.

May be photocopied for student use.

ELECTRICAL EQUIPMENT
UNIT 2

SUGGESTED ACTIVITIES

1. Suggested activities for instructor:

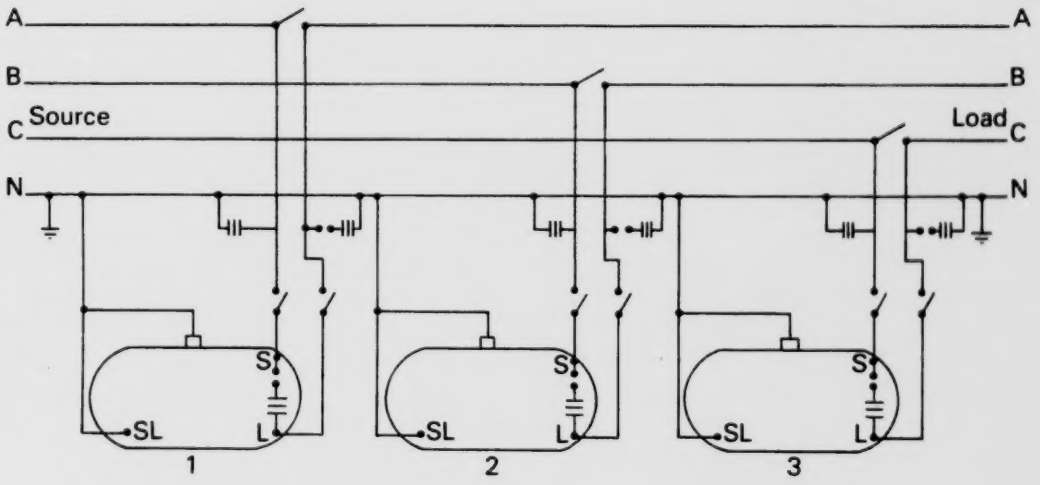
   - Provide student with objective sheet.
   - Provide student with information and assignment sheet.
   - Make transparencies.
   - Discuss unit and specific objectives.
   - Discuss information and assignment sheet.
   - Demonstrate the procedure for setting the voltage, time delay, and the line drop compensation on a voltage regulator.
   - Show films and other supplemental material on electrical equipment.
   - Give test.

2. Unit references:

   - *Power Line Technician.* Stillwater, OK: Oklahoma Department of Vocational and Technical Education, Curriculum and Instructional Materials Center, 1978.

ELECTRICAL EQUIPMENT
UNIT 2

ANSWERS TO ASSIGNMENT SHEET



ELECTRICAL EQUIPMENT
UNIT 2

ANSWERS TO TEST

1. a. 4
   b. 6
   c. 5
   d. 1
   e. 2
   f. 3
   g. 7
   h. 11
   i. 8
   j. 12
   k. 9
   l. 10
   m. 13
2. a. 4
   b. 6
   c. 2
   d. 1
   e. 3
   f. 5
3. a. 4
   b. 7
   c. 3
   d. 1
   e. 5
   f. 6
   g. 2

ANSWERS TO TEST

4.

a.	14	i.	13
b.	2	j.	10
c.	1	k.	5
d.	11	l.	6
e.	15	m.	7
f.	8	n.	9
g.	4	o.	12
h.	3	p.	16

5. The regulator which is farthest from the power source should be set with the longest time delay

6. a. Place the regulator in the Neutral position

   b. Turn the control and power switches to the Off position

   c. Close the bypass switch and open the source and load switches

7. (NOTE: Any four of the following precautions are acceptable.)

   - Size the regulator to the load requirements
   - Set the line drop compensator according to engineering recommendations
   - Set the bandwidth at the REA recommended setting of two volts
   - Set the shortest time delay on the regulator closest to the source
   - Do not bypass the regulator unless the regulator is in the Neutral position

8. a. Wait at least five minutes after disconnecting a capacitor before grounding it

   b. Keep capacitors short-circuited when stored or transported

   c. Dispose of faulty capacitors by sending to disposal company recommended by the manufacturer

   d. Do not re-fuse a capacitor if the case is distorted

   e. Always test capacitors before refusing

9. a, b, d, e

ANSWERS TO TEST

10. (NOTE: Any seven of the following are acceptable.)
    - Transformers
    - Capacitors
    - Regulators
    - Reclosers
    - Sectionalizers
    - Fuses
    - Metering equipment
    - Underground installations

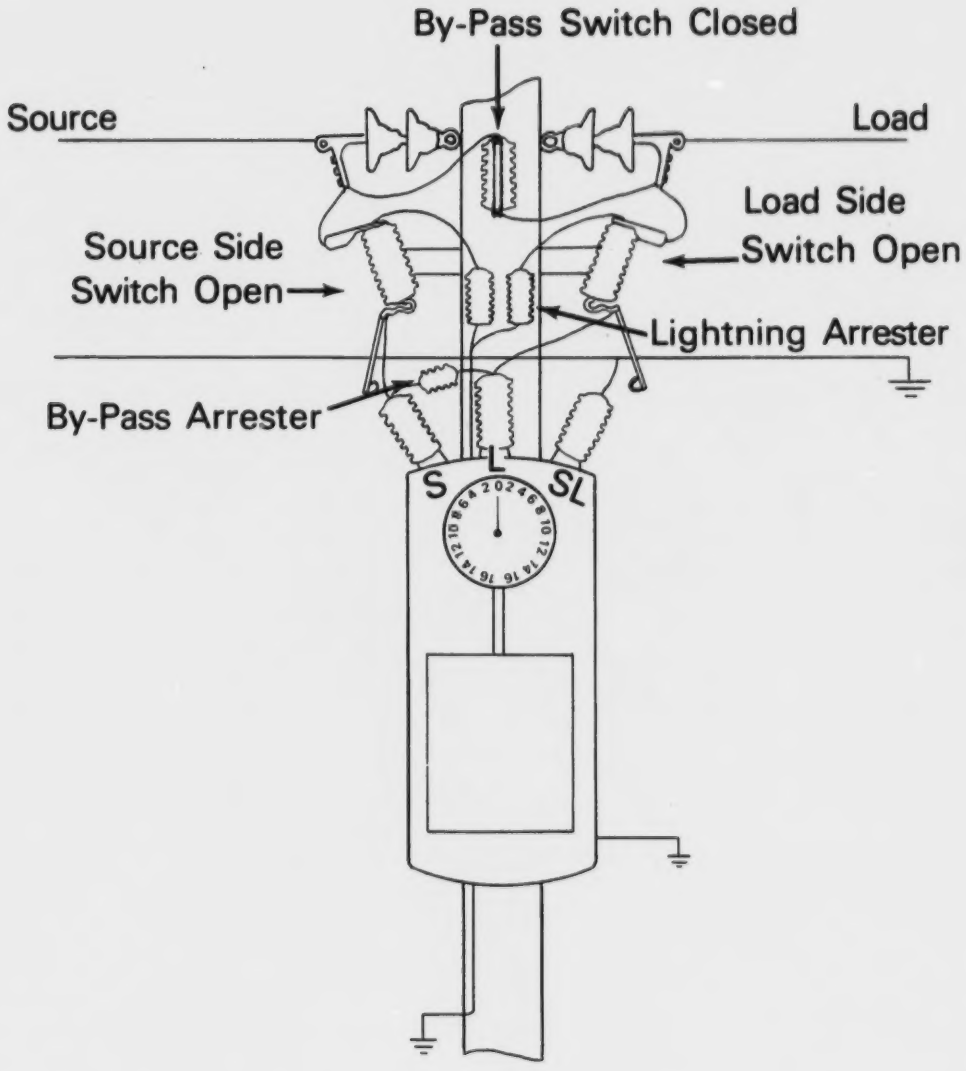
11. a. Reclosers with the same time-current characteristics
    b. Drop to the next smaller size
    c. When installing on taps or branch circuits

12. a. Size the sectionalizer to its back-up recloser
    b. Install sectionalizers on taps or branch circuits only
    c. Do not install sectionalizers and line fuses in series

13. b, c, d, e, f

14. Evaluated on Assignment Sheet 1.

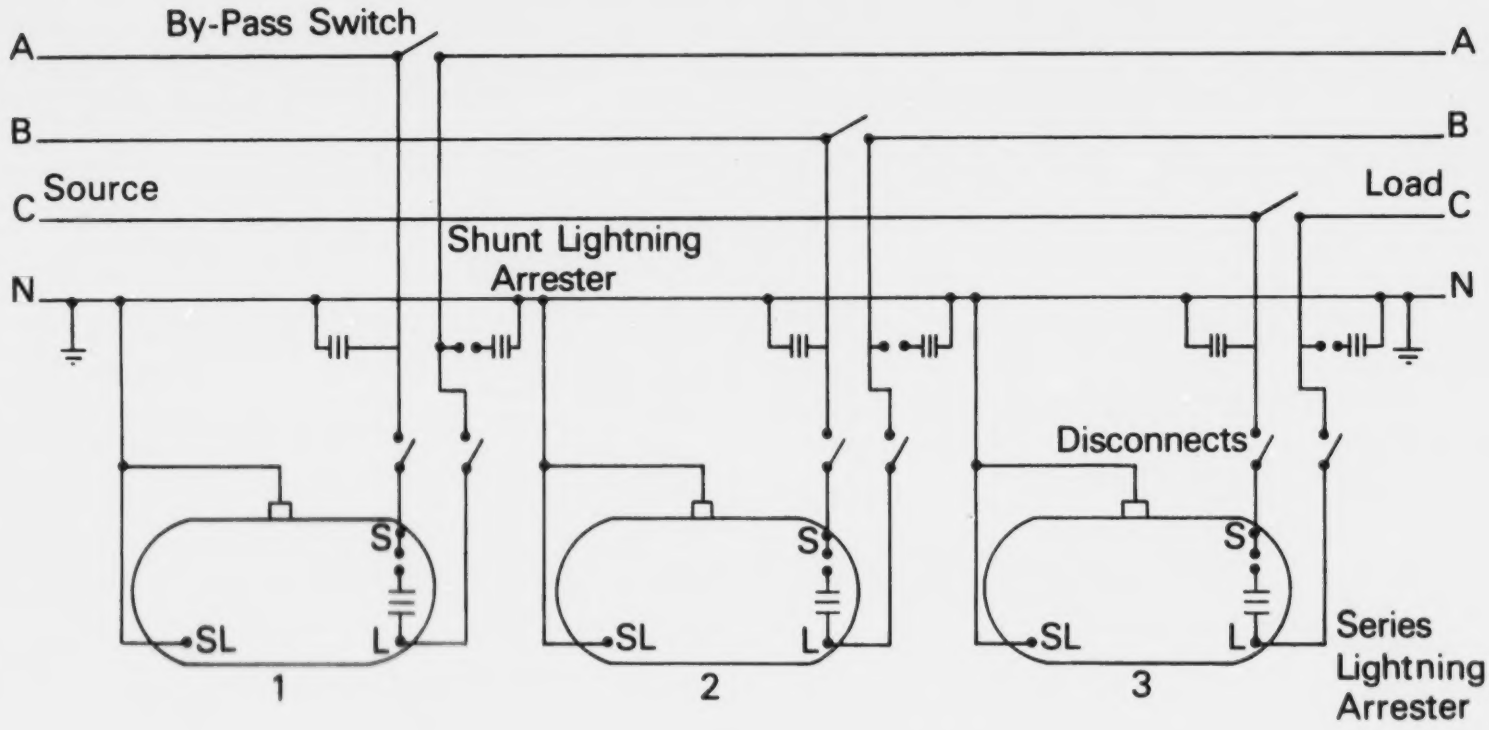
Voltage Regulator



TM 1

May be photocopied for student use.

Voltage Regulator Connections



Three-Phase, 4-Wire, Multi-Grounded Circuit Using Three Regulators.

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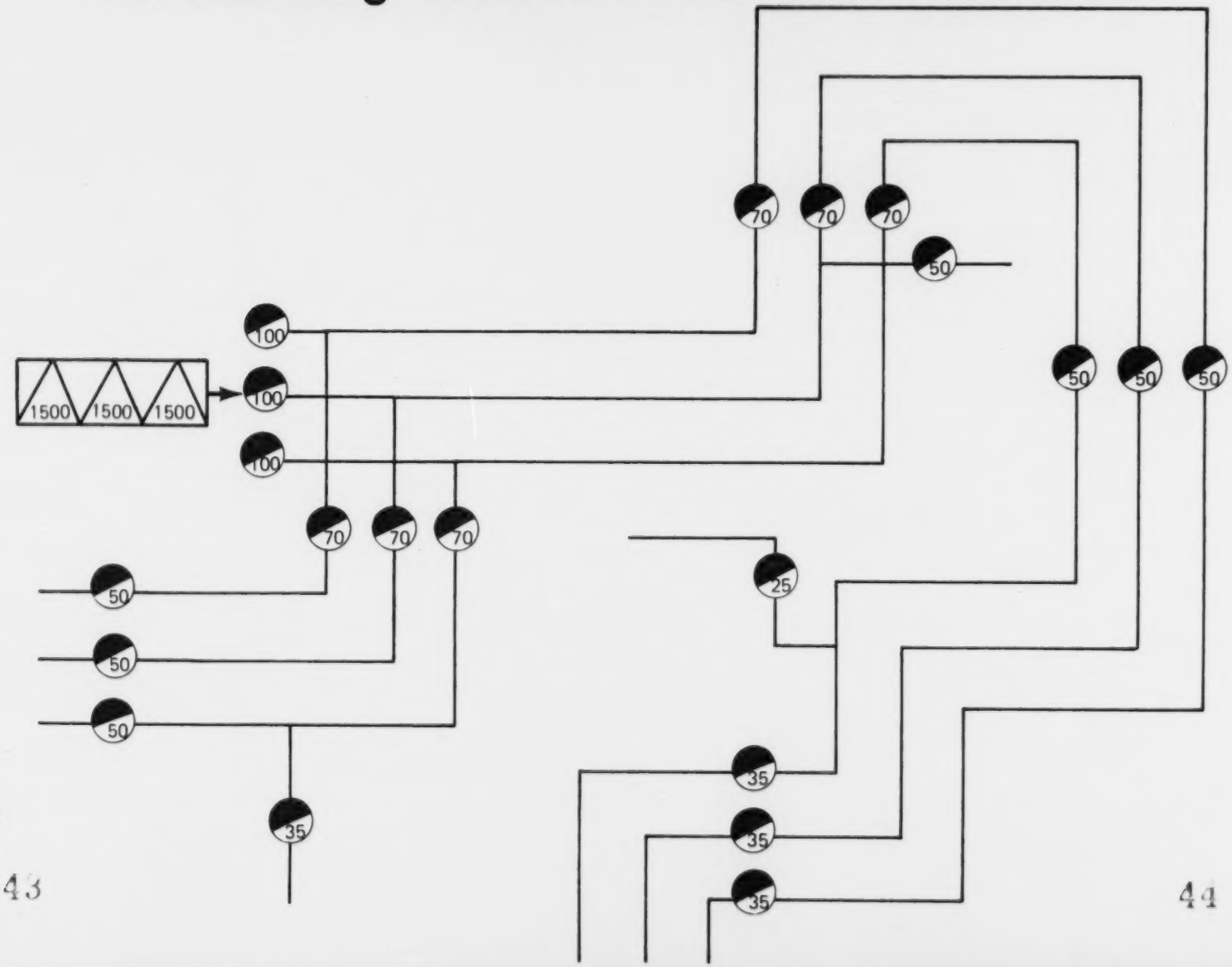
Coordinating Reclosers With Other Reclosers



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TM 3

PLT F - 2 - 13

ELECTRICAL EQUIPMENT
UNIT 2

TEST

NAME _____ SCORE _____

1. Match terms used with electrical equipment on the right to the correct definitions.

_____a.	Area above and below the voltage regulator setting within which the voltage may fluctuate without causing the regulator to operate	1.	Time delay
_____b.	Device which allows a voltage regulator to hold a desired voltage at some point along the line	2.	Voltage level setting
_____c.	Travel of the tap changer in either direction	3.	Short circuit strength
_____d.	Device which allows a predetermined response time for the regulator	4.	Bandwidth
_____e.	Control for desired voltage delivered to the consumer's meter	5.	Range of regulation
_____f.	Ability of a regulator to withstand 40 times the full-load current rating for 0.8 seconds without damage	6.	Line drop compensator
_____g.	Opposition to alternating current caused by a coil	7.	Inductive reactance
_____h.	Process by which an electrical conductor becomes energized when in a magnetic field or flux	8.	Inductor
_____i.	Part of electrical equipment which acts upon another part or itself by induction	9.	Inductance
_____j.	Opposition to alternating current caused by inductance, capacitance, or both in any circuit	10.	Capacitance
_____k.	Element in a circuit which opposes a change in the existing current	11.	Induction
		12.	Reactance
		13.	VAR (Volt-ampere reactance)

May be photocopied for student use

TEST

_____l. Storage of electrical energy

_____m. Unit of measurement of power produced by a capacitor

2. Match electrical equipment on the right to the correct uses.

_____a. Maintains a system voltage level within prescribed limits

_____b. Offsets the current losses and voltage drop caused by induction

_____c. Opens a circuit in case of a fault and operates four times before it locks open on a fault that does not clear

_____d. Is used in conjunction with an oil circuit recloser or a sectionalizer to clear a fault on a system

_____e. Is used in conjunction with an oil circuit recloser to open a circuit on the second or third operation of the recloser

_____f. Provides a low resistance path for high voltage surges and provides a high resistance path to current

1. Fused cutout
2. Oil circuit recloser
3. Sectionalizer
4. Voltage regulator
5. Lightning arrester
6. Capacitor

3. Arrange in order the steps to follow when connecting a voltage regulator to a three-phase line. Place a "1" before the first step, a "2" before the second step, and so on.

_____a. Connect "L" bushing to load side switch

_____b. Ground "SL" bushing to tank and system neutral

_____c. Connect source side switch to "S" bushing

_____d. Connect jumper to source side switch

_____e. Connect lightning arrester to load side switch

_____f. Connect load side switch to load line

_____g. Connect lightning arrester to source side switch

May be photocopied for student use.

TEST

4. Arrange in order the steps to follow when placing a voltage regulator in service. Place a "1" before the first step, a "2" before the second step, and so on.

_____a. Close the load side switch and open the bypass switch

_____b. Check the tank and "SL" bushing for solid grounds

_____c. Install regulator with source and load side switches open and bypass switch closed

_____d. Stop the regulator in the Neutral position

_____e. Set the control knob on Automatic

_____f. Count the steps as the regulator position indicator moves to the Neutral position

_____g. Turn the potential power switch to On

_____h. Energize the regulator by closing the source side switch only

_____i. Set the voltage level knobs to the desired voltage

_____j. Set control knob to Lower and count the steps as the regulator position indicator moves toward the Neutral position

_____k. Set the regulator control knob to Lower

_____l. Let the regulator stop at 16 Lower

_____m. Move the control knob to Raise

_____n. Let the regulator continue to 16 Raise

_____o. Turn the potential power switch and the control knob to the Off position

_____p. Check the output voltage with a calibrated voltmeter

5. State the procedure for setting voltage regulator time delays.

_____

_____

_____

May be photocopied for student use.

TEST

6. State the procedure for taking a voltage regulator out of service. The first word in each procedure is provided.

   a. Place — _____

   _____

   b. Turn — _____

   _____

   c. Close — _____

   _____

7. List four of the precautions to observe with voltage regulators.

   a. _____

   _____

   b. _____

   _____

   c. _____

   _____

   d. _____

   _____

8. List precautions to observe with capacitors. Some key words are provided.

   a. after disconnecting a capacitor — _____

   _____

   _____

   b. when stored or transported — _____

   _____

   _____

May be photocopied for student use.

TEST

c. faulty capacitors — _____

_____

_____

d. distorted — _____

_____

_____

e. test — _____

_____

_____

9. Select from a list the benefits of capacitor application. Place an "X" in front of the correct benefits.

_____a. Reduces line and transformer losses

_____b. Improves voltage level

_____c. Increases power flow

_____d. Improves efficiency of substation transformer

_____e. Reduces costs charged by power suppliers for poor power factor

10. Name seven of the pieces of equipment that should be protected by lightning arresters.

a. _____

b. _____

c. _____

d. _____

e. _____

f. _____

g. _____

May be photocopied for student use.

TEST

11. Explain the method of coordinating reclosers with other reclosers.

    a. *Which* reclosers should you select?

    _____

    _____

    b. When installing reclosers from the source, you should drop to *what size* toward the end of the line?

    _____

    _____

    c. You should drop the recloser two sizes when installing *where*?

    _____

    _____

12. List precautions to observe when installing sectionalizers. Key words are provided.

    a. Size — _____

    _____

    b. Install — _____

    _____

    c. in series — _____

    _____

13. Select from a list factors to consider when coordinating reclosers and fuses. Place an "X" in front of the correct factors.

    _____a. Set recloser for two operations only

    _____b. Select a fuse size with minimum melting and maximum clearing time-current characteristics which lie between the fast and time delay opening of the recloser

    _____c. Select fuse with a time-current characteristic as close as possible to the recloser time-current characteristic

    _____d. Select recloser with a coil small enough to detect minimum fault current on the line protected by the fuse

May be photocopied for student use.

TEST

_____e. Set recloser for a combination of fast and time delay operations

_____f. When refusing be sure to replace with same size and type

14. Evaluated on Assignment Sheet 1.

May be photocopied for student use.

WORK PROCEDURES
(HOT LINE, BASKET, HOT STICK)
UNIT 3

SUGGESTED ACTIVITIES

1. Suggested activities for instructor:

   - Provide student with objective sheet.
   - Provide student with information sheet.
   - Discuss unit and specific objectives.
   - Discuss information sheet.
   - Discuss and demonstrate the procedures outlined on the job sheets.
   - Show films and other supplemental information on hot line maintenance.
   - Give test.

2. Unit references:

   - *Power Line Technician.* Stillwater, OK: Oklahoma Department of Vocational and Technical Education, Curriculum and Instructional Materials Center, 1978.

WORK PROCEDURES
(HOT LINE, BASKET, HOT STICK)
UNIT 3

ANSWERS TO TEST

1. a. Insulated aerial device

   b. Hot line tool

2. a, c, d, e, f

3. a, b, c, d, e, f, h, i, j, k, l, m

4. (NOTE: Any six of the following answers are acceptable.)

   - Replacing insulators
   - Replacing crossarms
   - Replacing poles
   - Installing armor rods
   - Splicing conductor
   - Cutting double dead end
   - Cutting slack in or out of conductor
   - Tapping a hot line

5. a. Lower or cover the neutral and grounded parts

   b. Work on only one conductor at a time

   c. Cover and place energized conductors on insulated lifting attachments

   d. Tension energized conductor with rope block or insulated hoist

   e. Hang handline on structure not on basket

   f. Install insulated jumper on conductor before opening a circuit

ANSWERS TO TEST

6.
a.	9	h.	8
b.	1	i.	13
c.	11	j.	12
d.	14	k.	7
e.	6	l.	5
f.	10	m.	4
g.	2	n.	3

7.
a.	8	h.	3
b.	5	i.	12
c.	10	j.	7
d.	1	k.	4
e.	6	l.	9
f.	2	m.	13
g.	11		

8. Evaluated on Job Sheet 1.

9. Evaluated on Job Sheet 2.

WORK PROCEDURES
(HOT LINE, BASKET, HOT STICK)
UNIT 3

TEST

NAME _____ SCORE _____

1. List methods of hot line maintenance.

   a. _____

   b. _____

2. Select from a list OSHA requirements for aerial devices. Place an "X" in front of the correct requirements.

   _____a. Controls shall be plainly marked as to their functions

   _____b. Load limits may be exceeded if necessary

   _____c. Boom shall be cradled and outriggers shall be in the stowed position before moving vehicle

   _____d. Lift controls shall be tested each day prior to use

   _____e. Load limits of the equipment shall not be exceeded

   _____f. Only trained and authorized persons shall operate an aerial device

3. Select from a list rules to observe when working with an aerial device. Place an "X" in front of the correct rules.

   _____a. Climbers shall not be worn when working from an aerial device

   _____b. Rubber gloves and rubber sleeves must be worn while working energized primary from an aerial device

   _____c. Position the device so that no contact will be made between conductors or other equipment

   _____d. No person shall stand directly beneath the work area of an aerial device

   _____e. Safety hat and suitable clothing shall be worn when working with an aerial device

   _____f. Vehicle frame shall be grounded while the basket is in use near high voltage lines

   _____g. Climbers may be worn in a basket if the basket has a liner

May be photocopied for student use

TEST

_____h. Assurance shall be made that the boom or basket is not in contact with an energized conductor before entering or leaving the vehicle

_____i. A body harness with a securing strap shall be worn while working from an aerial basket

_____j. Tools or equipment shall not be thrown to or from an aerial device

_____k. The operator of the lower controls shall be on the vehicle or at the same potential as the vehicle

_____l. Transfer to or from a structure and an aerial device shall not be allowed

_____m. An aerial device shall be considered energized at line potential when the boom or basket is in close proximity to an energized conductor

4. List six of the elements of hot line maintenance.

a. _____

b. _____

c. _____

d. _____

e. _____

f. _____

5. State the procedure for hot line maintenance from an aerial device. Key words are provided.

a. Lower or cover — _____

_____

b. Work on — _____

_____

c. Cover and place — _____

_____

d. Tension — _____

_____

May be photocopied for student use

TEST

e. Hang — _____

_____

f. Before opening a circuit — _____

_____

6. Arrange in order the steps to follow when changing a pole top insulator from a basket. Place a "1" before the first step, a "2" before the second step, and so on.

_____a. Place line hose on the energized conductor near the insulator

_____b. Place warning signs at the work site

_____c. Untie the energized conductor

_____d. Move conductor back to insulator and retie

_____e. Ground the vehicle frame to the system neutral or a driven ground

_____f. Secure the energized conductor to an insulated attachment

_____g. Position basket truck near the pole

_____h. Elevate the basket to near the pole top and cover the pole top with a rubber blanket

_____i. Allow line technician on pole to change the insulator

_____j. Move conductor away from pole

_____k. Raise basket to neutral position and cover or lower the neutral

_____l. Clear the area near the vehicle and lower the outriggers

_____m. Check the outrigger footings for stability

_____n. Set the vehicle brakes and chock the wheels

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TEST

7. Match various hot line tools on the right to their specific uses.

_____a.	Attaches to and holds conductor	1. Wire cutter
_____b.	Secures to pole and holds wire tong	2. Rural strain carrier
_____c.	Unties and ties conductor	3. Pole gin
_____d.	Cuts energized conductor and tie wire	4. Universal platform
_____e.	Holds conductor aside when pole is being relocated	5. Wire tong saddle
_____f.	Supports conductor while suspension insulators are being changed	6. Link stick
_____g.	Lowers and raises insulator string	7. Auxiliary arm
_____h.	Extends a pole to lay out conductor	8. Wire tong
_____i.	Attachment point for rope blocks to raise and lower transformer	9. Hook ladder
_____j.	Holds conductors out of the way of repairs or is used to raise conductors above work area	10. Tie stick
_____k.	Supports line technician near work area	11. Insulator cradle
_____l.	Supports the line technician so the conductor may be reached with wire tong or other hot stick	12. Transformer gin
_____m.	Attaches to various tools which enable the line technician to tighten or remove clamps, connectors, bolts, and cotter keys	13. Universal hot stick

8. Evaluated on Job Sheet 1.

9. Evaluated on Job Sheet 2.

May be photocopied for student use

TROUBLESHOOTING
(SECONDARY)
UNIT 4

SUGGESTED ACTIVITIES

1. Suggested activities for the instructor:

   - Provide student with objective sheet.
   - Provide student with information sheet.
   - Discuss unit and specific objectives.
   - Discuss information sheet.
   - Discuss troubleshooting problems you have encountered.
   - Give test.

2. Unit reference

   - *Power Line Technician.* Stillwater, OK: Oklahoma Department of Vocational and Technical Education, Curriculum and Instructional Materials Center, 1978.

TROUBLESHOOTING
(SECONDARY)
UNIT 4

ANSWERS TO TEST

1. a. 4 e. 3
   b. 6 f. 5
   c. 8 g. 2
   d. 1 h. 7
2. a. 5
   b. 2
   c. 1
   d. 3
   e. 4
3. a. 4
   b. 1
   c. 5
   d. 3
   e. 2
4. a. Wear protective equipment
   b. Assume that conductors and equipment are energized
   c. Use proper test equipment
5. a, b, c, d, f, g

TROUBLESHOOTING
(SECONDARY)
UNIT 4

TEST

NAME _____ SCORE _____

1. Match the terms associated with troubleshooting on the right to the correct definitions.

_____a.	Loss of power on one phase of a three-phase primary or secondary circuit	1. Eddy current
_____b.	Extreme swing in voltage above and below voltage base	2. Relay
_____c.	Two phases that become energized from a single-phase source	3. Interlock
_____d.	Current induced in and around a transformer core or a conductor where it causes heating; current which flows contrary to the main current flow	4. Single phasing
_____e.	Electrical unit that prevents simultaneous operation of equipment	5. Operation
_____f.	Function of a switch or circuit breaker	6. Voltage fluctuation
_____g.	Electrically operated device that opens and closes a circuit	7. Trip
_____h.	Function of a piece of equipment to open a circuit	8. Common phases

2. Match indications of malfunctions on the right to the possible causes.

_____a.	Transformer too small; service conductor too small; increased load on consumer's premises; distance to power source too great; voltage regulator inoperative; line capacitors out of service	1. Blinking lights
_____b.	Transformer tap set too high; transformer winding damaged; voltage regulator inoperative; high capacitance on primary line; open neutral on secondary; open ground on transformer tank	2. High voltage
		3. Potential on water pipes or appliances
		4. Frequent service breaker tripping
		5. Low voltage

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TEST

_____c. Poor connection at transformer; poor connection in meter base; improper connector on service wire; meter lugs burned or bent; trees in secondary or service

_____d. Open neutral on secondary; grounds not interconnected; faulted motor winding; faulted fluorescent ballast; equipment or appliances not grounded

_____e. Breaker overloaded; poor connection at breaker terminals; breaker contacts burned; fault on circuit with high resistance to ground

3. Arrange in order the correct procedure for troubleshooting electrical equipment. Place a "1" before the first procedure, a "2" before the second procedure, and so on.

_____a. Make repairs or corrections if problem is not on consumer's side of the meter

_____b. Obtain all information available about the problem

_____c. Make report on findings and action taken

_____d. Discuss findings with consumer

_____e. Check voltage, amperage, transformer size, and service size

4. List precautions to observe when troubleshooting electrical equipment.

a. _____

b. _____

c. _____

5. Select from a list items of information to obtain while troubleshooting. Place an "X" in front of the correct items.

_____a. Number of consumers affected by problem

_____b. Consumer' name

_____c. Time and date trouble began

_____d. Consumer's location

_____e. Size of consumer's dwelling

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TEST

_____f. Circumstances which might have caused problem

_____g. Consumer's complaint

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A CIMC "RAINBOW PROGRAM"

FOR STANDARDS OF TEACHING EXCELLENCE

STUDENT'S PROMISE

One very important factor contributing to higher student performance is the expectation of parents and teachers. Experience suggests that teachers and parents who expect student success find that students perform better, attend class more regularly, have positive attitudes, and stay in school longer. The students' success and confidence in their ability to learn may cause additional growth and behaviors that exert a positive influence throughout life.

Let it be publicly known that students in this program have high expectations of achievement.

I recognize that America's future is dependent on my success in school.
I will attend school regularly.
I will keep regular study hours at home.
I will read each day at home.
I will never accept failure.
I will accept responsibility for my school challenges.
I will respect the rights and feelings of others at home, school, and work.
I will develop positive qualities in myself that my friends will admire.
If I have difficulty, I will insist on help with my school work.
If I have difficulty, I will always try harder.
I will ask my teacher for clear learning objectives.
I will practice good citizenship skills at home, school, and work.
I will keep my parents/guardians informed daily about my school activities.
I will develop goals for school, home, and work.
I will seek advice from my teachers, parents/guardians, and counselors on career guidance.
I will constantly practice the skills of a good student.

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Power Line Technician

Second Edition

Module F

- Line Patrol
- Electrical Equipment
- Work Procedures (Hot Line, Basket, Hot Stick)
- Troubleshooting (Secondary)

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Student Workbook

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Power Line Technician: Module F

Student Workbook

Developed by the
Curriculum and Instructional Materials Center
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1. Personal and Job Safety
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2. Electrical Equipment
3. Work Procedures (Hot Line, Basket, Hot Stick)
4. Troubleshooting (Secondary)

MODULE G

1. Troubleshooting (Primary Line)
2. System Knowledge (Phase II)
3. Conversions

LINE PATROL
UNIT 1

UNIT OBJECTIVE

After completion of this unit, the student should be able to list specific conditions that should be observed during patrol and complete a line inspection form. This knowledge will be evidenced by scoring 85 percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match types of line patrol to the specific purpose.
2. Select from a list items to observe when patrolling line.
3. Match items to the specific conditions to observe when patrolling a line.
4. List methods of line patrol.
5. Select from a list requirements of a line patroller.
6. List items to observe with line equipment.
7. Complete a line inspection form. (Assignment Sheet 1)

LINE PATROL
UNIT 1

INFORMATION SHEET

1. Match types of line patrol to the specific purpose.

   - Regular patrol — Examine and report the condition of each pole, insulator, and conductor and all right-of-ways
   - Emergency patrol — Locate a fault or problem without delay to restore service or to prevent an outage
   - Special patrol — Compile detailed information on an existing line for a line change such as a line move, a rebuild, or reconductoring
   - Follow-up patrol — Determine the cause of a problem such as blinking lights or breaker operations

2. Select from a list items to observe when patrolling line.

   - Clearances
   - Conductors
   - Construction near line
   - Crossarms
   - Crossings
   - Foreign objects on poles
   - Ground wires
   - Guys
   - Hardware
   - Insulators
   - Jumpers
   - Kites or kite string
   - Line equipment
   - Poles

INFORMATION SHEET

- Radio interference
- Sag
- Tie wires
- Trees
- Washes near poles
- Woodpecker holes

3. Match items to the specific conditions to observe when patrolling a line.

   - Conductors — Burned spots; broken or frayed strands
   - Crossarms — Cracks, splits or loose hardware
   - Crossings — Insufficient clearance over road or from other utilities
   - Ground wires — Loose connector at neutral or stapes not driven into pole
   - Guys — Broken anchor rod or stretched conductor
   - Hardware — Loose nuts, washers, or connectors
   - Insulators — Cracks, chips, or blackening
   - Jumpers — Slack enough to blow into pole or equipment
   - Poles — Leaning, washed out, or graded out
   - Sag — Insufficient separation of conductors
   - Trees — Near enough to blow into conductor or break off and fall onto conductor

     (NOTE: Burned spots in trees indicate that the trees have been touching or blowing into an energized conductor.)

4. List methods of line patrol.

   - Foot
   - Vehicle
   - Aircraft
   - Boat

INFORMATION SHEET

5. Select from a list requirements of a line patroller.

   - Observe all parts of line being patrolled
   - Distinguish between hazardous and nonhazardous conditions
   - Make a written report of the line conditions observed
   - Make a list of materials and equipment needed to make repairs
   - Follow up on reported conditions to see that repairs are made

   (NOTE: A line inspection will be required in addition to patrols in order to make a complete inspection of pole conditions and equipment operation.)

6. List items to observe with line equipment.

   - Broken, cracked, or chipped bushings
   - Oil leaks
   - Temperature indicators
   - Operation counter
   - Lightning arrester gaps

7. Complete a line inspection form. (Assignment Sheet 1)

LINE PATROL
UNIT 1

ASSIGNMENT SHEET

OBJECTIVE 7 — COMPLETE A LINE INSPECTION FORM.

Study the sample completed form on the next page, then use an existing distribution line to complete the blank line inspection form.

(NOTE: A complete inspection of a distribution system should be made every five to eight years with about 20 percent of the system being inspected each year. A typical line inspection form is included on the following page; however, forms will vary in content between organizations.)

PLT F - 1 - 8

ASSIGNMENT SHEET

LINE 12 E 5

INSPECTOR L.J. BLOW DATE 6-6-95

NOTES

Pole 10 needs to be moved 20 Feet South to avoid a wash out. - Insulators need to be replaced on poles 3, 4, & 19.

POLE NO	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
SIZE	30/5	30/5	35/6	40/5	36/6	30/6	30/6	35/6	35/6	40/5	40/5	35/6	30/6	35/5	30/5	30/6	35/6	35/6	35/5	
CLIMB-INSPECT			✓		✓	✓	✓	✓	✓			✓	✓		✓	✓	✓			
HARDWARE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
KEYS-PINS	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
INSULATOR	✓	✓	X	✓	✓	✓	✓	✓	X	✓	✓	✓	✓	✓	✓	✓	✓	✓	X	
FRAMING	A4	VA1	VA1	VA1	VA1	VA1	VA1	VA1	VA1	VA1	VA1	VA1	VA1	VA1	VA1	VA1	VA1	VA1	VA5	
SOUND POLE			✓		✓	✓	✓	✓	✓			✓	✓			✓	✓	✓		
PLUMB & RETAMP										✓										
GUYS-TIGHTEN	✓																		✓	
ANCHOR RODS																				
UNDERBUILD																				
FOREIGN LINES																				

ROAD-CREEK-CANYON Creek washing out near pole 10

TREES CUT-FEET

TREES POISONED-FEET 110' between poles 6 & 7 - permission obtained from owner

LINE

INSPECTOR DATE

NOTES

POLE NO																				
SIZE																				
CLIMB-INSPECT																				
HARDWARE																				
KEYS-PINS																				
INSULATOR																				
FRAMING																				
SOUND POLE																				
PLUMB & RETAMP																				
GUYS-TIGHTEN																				
ANCHOR RODS																				
UNDERBUILD																				
FOREIGN LINES																				

ROAD-CREEK-CANYON

TREES CUT-FEET

TREES POISONED-FEET

ASSIGNMENT SHEET

PLT F - 1 - 9

77

78

ELECTRICAL EQUIPMENT
UNIT 2

UNIT OBJECTIVE

After completion of this unit, the student should be able to put a voltage regulator in or out of service with safety. The student should be able to disconnect, transport, and store capacitors safely. The student should be able to protect line equipment by installing protective equipment. This knowledge will be evidenced by scoring 85 percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms used with electrical equipment to the correct definitions.
2. Match electrical equipment to the specific uses.
3. Arrange in order the steps to follow when connecting a voltage regulator to a three-phase line.
4. Arrange in order the steps to follow when placing a voltage regulator in service.
5. State the procedure for setting voltage regulator time delays.
6. State the procedure for taking a voltage regulator out of service.
7. List precautions to observe with voltage regulators.
8. List precautions to observe with capacitors.
9. Select from a list the benefits of capacitor application.
10. Name equipment that should be protected by lightning arresters.
11. Explain the method of coordinating reclosers with other reclosers.
12. List precautions to observe when installing sectionalizers.
13. Select from a list factors to consider when coordinating reclosers and fuses.
14. Connect voltage regulators to a three-phase line. (Assignment Sheet 1)

ELECTRICAL EQUIPMENT
UNIT 2

INFORMATION SHEET

1. Match terms used with electrical equipment to the correct definitions.

   - Bandwidth — Area above and below the voltage regulator setting within which the voltage may fluctuate without causing the regulator to operate
   - Line drop compensator — Device which allows a voltage regulator to hold a desired voltage at some point along the line
   - Range of regulation — Travel of the tap changer in either direction
   - Time delay — Device which allows a predetermined response time for the regulator
   - Voltage level setting — Control for desired voltage delivered to the consumer's meter
   - Short circuit strength — Ability of a regulator to withstand 40 times the full-load current rating for 0.8 seconds without damage
   - Induction — Process by which an electrical conductor becomes energized when in a magnetic field or flux
   - Inductor — Part of electrical equipment which acts upon another part or itself by induction
   - Inductance — Element in a circuit which opposes a change in the existing current
   - Capacitance — Storage of electrical energy
   - Reactance — Opposition to alternating current caused by inductance, capacitance, or both in any circuit
   - Inductive reactance — Opposition to alternating current caused by a coil
   - VAR (volt-ampere reactance) — Unit of measurement of power produced by a capacitor

2. Match electrical equipment to the specific uses.

   - Voltage regulator — Maintains a system voltage level within prescribed limits (Transparency 1)
   - Capacitor — Offsets the current losses and voltage drop caused by induction

INFORMATION SHEET

- Oil circuit recloser — Opens a circuit in case of a fault and operates four times before it locks open on a fault that does not clear
- Sectionalizer — Is used in conjunction with an oil circuit recloser to open a circuit on the second or third operation of the recloser
- Fused cutout — Is used in conjunction with an oil circuit recloser or a sectionalizer to clear a fault on a system
- Lightning arrester — Provides a low resistance path for high voltage surges and provides a high resistance path to current (Transparency 1)

3. Arrange in order the steps to follow when connecting a voltage regulator to a three-phase line. (Transparency 2, Assignment Sheet 1)

- Connect jumper to source side switch
- Connect lightning arrester to source side switch
- Connect source side switch to "S" bushing
- Connect "L" bushing to load side switch
- Connect lightning arrester to load side switch
- Connect load side switch to load line
- Ground "SL" bushing to tank and system neutral

4. Arrange in order the steps to follow when placing a voltage regulator in service. (Transparency 1)

- Install regulator with source and load side switches open and bypass switch closed

  (NOTE: Do not energize the regulator.)
- Check the tank and "SL" bushing for solid grounds
- Energize the regulator by closing the source side switch only
- Turn the potential power switch to On
- Set the regulator control knob to Lower
- Let the regulator stop at 16 Lower
- Move the control knob to Raise

INFORMATION SHEET

- Count the steps as the regulator position indicator moves to the Neutral position

  (NOTE: On a thirty-two step regulator, this should be sixteen steps.)

- Let the regulator continue to 16 Raise

- Set control knob to Lower and count the steps as the regulator position indicator moves toward the Neutral position

- Stop the regulator in the Neutral position

  (NOTE: Counting the steps in both directions insures that the regulator is in the Neutral position when the indicator shows it to be.)

- Turn the potential power switch and the control knob to the Off position

- Set the voltage level knobs to the desired voltage

- Close the load side switch and open the bypass switch

  (CAUTION: Serious damage and possible injury will result if a regulator is put into service without being set in the Neutral position before the load side switch is closed and the bypass switch is opened.)

- Set the control knob on Automatic

- Check the output voltage with a calibrated voltmeter

5. State the procedure for setting voltage regulator time delays.

   The regulator which is farthest from the power source should be set with the longest time delay

6. State the procedure for taking a voltage regulator out of service.

   - Place the regulator in the Neutral position

     (CAUTION: If the regulator has malfunctioned and cannot be moved to the Neutral position, the line should be de-energized to take the regulator out of service.)

   - Turn the control and power switches to the Off position

   - Close the bypass switch and open the source and load switches

INFORMATION SHEET

7. List precautions to observe with voltage regulators.

   - Size the regulator to the load requirements

     (NOTE: A regulator which is too small will soon be damaged by overload.)

   - Set the line drop compensator according to engineering recommendations
   - Set the bandwidth at the REA recommended setting of two volts
   - Set the shortest time delay on the regulator closest to the source
   - Do not bypass the regulator unless the regulator is in the Neutral position

8. List precautions to observe with capacitors.

   (CAUTION: A capacitor may retain a hazardous charge for an indefinite time after being disconnected.)

   - Wait at least five minutes after disconnecting a capacitor before grounding it
   - Keep capacitors short-circuited when stored or transported
   - Dispose of faulty capacitors by sending to disposal company recommended by the manufacturer
   - Do not re-fuse a capacitor if the case is distorted
   - Always test capacitors before re-fusing

9. Select from a list the benefits of capacitor application.

   - Improves power factor
   - Reduces costs charged by power suppliers for poor power factor
   - Improves voltage level
   - Reduces line and transformer losses
   - Improves efficiency of substation transformer

10. Name equipment that should be protected by lightning arresters.

    - Transformers
    - Capacitors
    - Regulators

INFORMATION SHEET

- Reclosers
- Sectionalizers
- Fuses
- Metering equipment
- Underground installations

11. Explain the method of coordinating reclosers with other reclosers. (Transparency 3)

- Select reclosers with the same time-current characteristics

  (NOTE: Reclosers of the same make, type, and operation sequence will simplify recloser coordination.)

- Install reclosers from the source, dropping to the next smaller size toward the end of the line

  Example: 100 ampere-rated recloser at the substation, 70 ampere-rated recloser three miles from the substation, 50 ampere-rated recloser seven miles from the substation, 35 ampere-rated recloser ten miles from the substation

- Drop the recloser two sizes when installing on taps or branch circuits

  Example: Recloser installed on the taps between the substation (100 ampere OCR) and the next 70 ampere OCR may be 50 ampere rated

  (NOTE: Any recloser should have a generous margin between the interrupting rating and the available short-circuit current at the location of installation.)

12. List precautions to observe when installing sectionalizers.

- Size the sectionalizer to its back-up recloser

  Example: 100 ampere recloser and 100 ampere sectionalizer

- Install sectionalizers on taps or branch circuits only

  (NOTE: Sectionalizers have no inherent capacity to interrupt fault currents and should never be placed between reclosers. A sectionalizer will open on the first or second operation of the recloser during the open-circuit time of the recloser.)

- Do not install sectionalizers and line fuses in series

INFORMATION SHEET

13. Select from a list factors to consider when coordinating reclosers and fuses.

- Set recloser for a combination of fast and time delay operations

  (NOTE: The recloser is usually set for two fast and two delay operations.)

- Select a recloser with a coil small enough to detect minimum fault current on the line protected by the fuse

- Select fuse with a time-current characteristic as close as possible to the recloser time-current characteristic

  (NOTE: Use the manufacturer's fuse curve scale to calculate the fuse characteristics.)

- Select a fuse size with minimum melting and maximum clearing time-current characteristics which lie between the fast and time delay opening of the recloser

- When re-fusing be sure to replace with same size and type

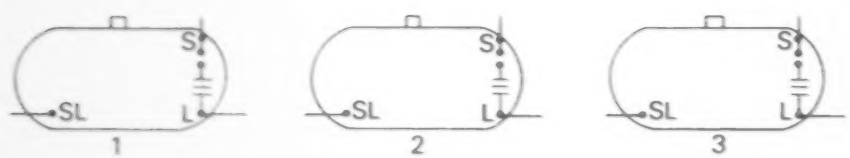
  (NOTE: Check with engineer for changes.)

ELECTRICAL EQUIPMENT
UNIT 2

ASSIGNMENT SHEET 1

OBJECTIVE 14 — CONNECT VOLTAGE REGULATORS TO A THREE-PHASE LINE.

Draw lines to connect the three regulators to the three-phase line. Include all switches, grounds, and lightning arresters.



WORK PROCEDURES
(HOT LINE, BASKET, HOT STICK)
UNIT 3

UNIT OBJECTIVE

After completion of this unit, the student should be able to list elements of hot line maintenance and follow prescribed procedures and requirements for hot line maintenance. The student should be able to change an insulator with hot line tools. This knowledge will be evidenced through demonstration and by scoring 85 percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. List methods of hot line maintenance.
2. Select from a list OSHA requirements for aerial devices.
3. Select from a list rules to observe when working with an aerial device.
4. List elements of hot line maintenance.
5. State the procedure for hot line maintenance from an aerial device.
6. Arrange in order the steps to follow when changing a pole top insulator from a basket.
7. Match various hot line tools to their specific uses.
8. Install a wire tong saddle. (Job Sheet 1)
9. Change an insulator on an energized conductor using hot line tools on an A1 structure. (Job Sheet 2)

WORK PROCEDURES
(HOT LINE, BASKET, HOT STICK)
UNIT 3

INFORMATION SHEET

1. List methods of hot line maintenance.

   - Insulated aerial device

     Examples: Basket, bucket, or ladder

   - Hot line tool

     Examples: Hot stock, cover-up material

2. Select from a list OSHA requirements for aerial devices.

   - Lift controls shall be tested each day prior to use
   - Only trained and authorized persons shall operate an aerial device
   - Load limits of the equipment shall not be exceeded
   - Controls shall be plainly marked as to their functions
   - Boom shall be cradled and outriggers shall be in the stowed position before moving vehicle

3. Select from a list rules to observe when working with an aerial device.

   (NOTE: Inspect the vehicle and aerial device daily.)

   - Position the device so that no contact will be made between conductors or other equipment
   - Rubber gloves and rubber sleeves shall be worn while working energized primary from an aerial device

     (NOTE: Wear rubber gloves and rubber sleeves from stored position to stored position.)

   - Safety hat and suitable clothing shall be worn when working with an aerial device
   - Transfer to or from a structure and an aerial device shall not be allowed
   - Climbers shall not be worn when working from an aerial device
   - No person shall stand directly beneath the work area of an aerial device

INFORMATION SHEET

- An aerial device shall be considered energized at line potential when the boom or basket is in close proximity to an energized conductor
- Tools or equipment shall not be thrown to or from an aerial device
- The operator of the lower controls shall be on the vehicle or at the same potential as the vehicle
- Assurance shall be made that the boom or basket is not in contact with an energized conductor before entering or leaving the vehicle
- Vehicle frame shall be grounded while the basket is in use near high voltage lines

  (NOTE: A driven ground rod or system neutral should be used for grounding the vehicle.)
- A body harness with a securing strap shall be worn while working from an aerial basket

4. List elements of hot line maintenance.

- Replacing insulators
- Replacing crossarms
- Replacing poles
- Installing armor rods
- Splicing conductor
- Cutting double dead end
- Cutting slack in or out of conductor
- Tapping a hot line

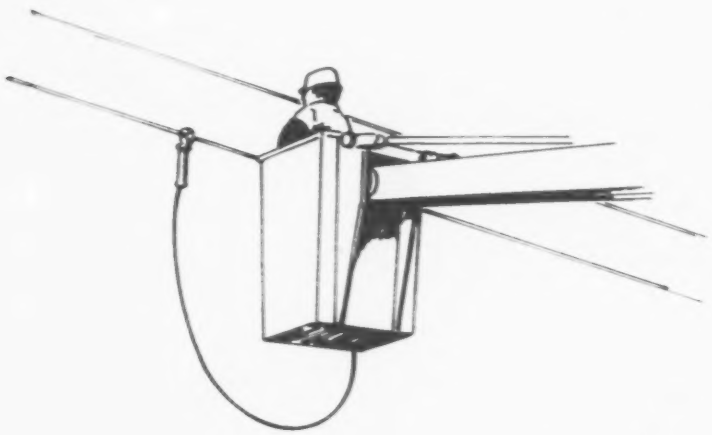
5. State the procedure for hot line maintenance from an aerial device.

- Lower or cover the neutral and grounded parts
- Work on only one conductor at a time
- Cover and place energized conductors on insulated lifting attachments
- Tension energized conductor with rope block or insulated hoist
- Hang handline on structure, not on basket

  (NOTE: Only high dialectric rope shall be used for handlines that are used in hot line work.)

INFORMATION SHEET

- Install insulated jumper on conductor before opening a circuit



6. Arrange in order the steps to follow when changing a pole top insulator from a basket.

- Place warning signs at the work site

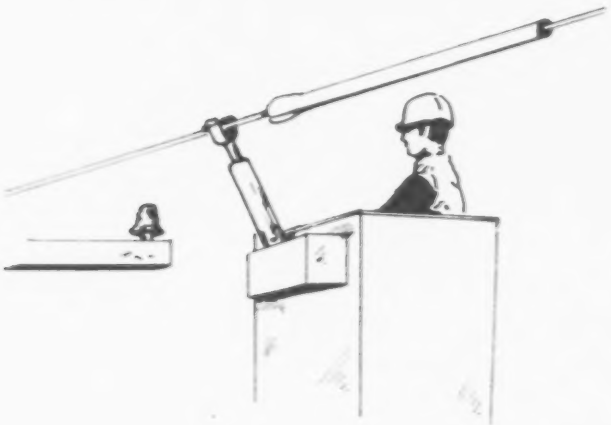
  (NOTE: See Federal Highway Administration and your state requirements.)

- Position basket truck near the pole
- Set the vehicle brakes and chock the wheels
- Check the outrigger footings for stability
- Clear the area near the vehicle and lower the outriggers
- Ground the vehicle frame to system neutral or a driven ground
- Raise basket to neutral position and cover or lower the neutral
- Elevate the basket to near the pole top and cover the pole top with a rubber blanket
- Place line hose on the energized conductor near the insulator

  (NOTE: This should be done without touching phase wire.)

INFORMATION SHEET

- Secure the energized conductor to an insulated attachment



(NOTE: Make sure conductor is locked into lifting attachment.)

- Untie the energized conductor

(CAUTION: Use a tie stick or pliers to untie the conductor to avoid puncturing your rubber gloves.)

- Move conductor away from pole
- Allow line technician on pole to change the insulator
- Move conductor back to insulator and retie

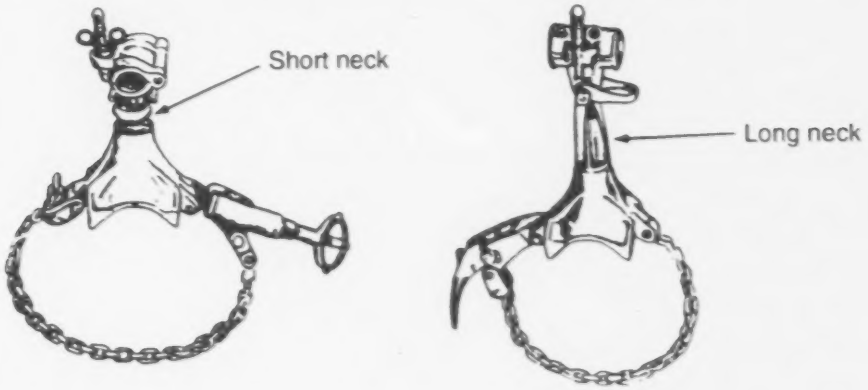
7. Match various hot line tools to their specific uses.

- Wire tong — Attaches to and holds conductor

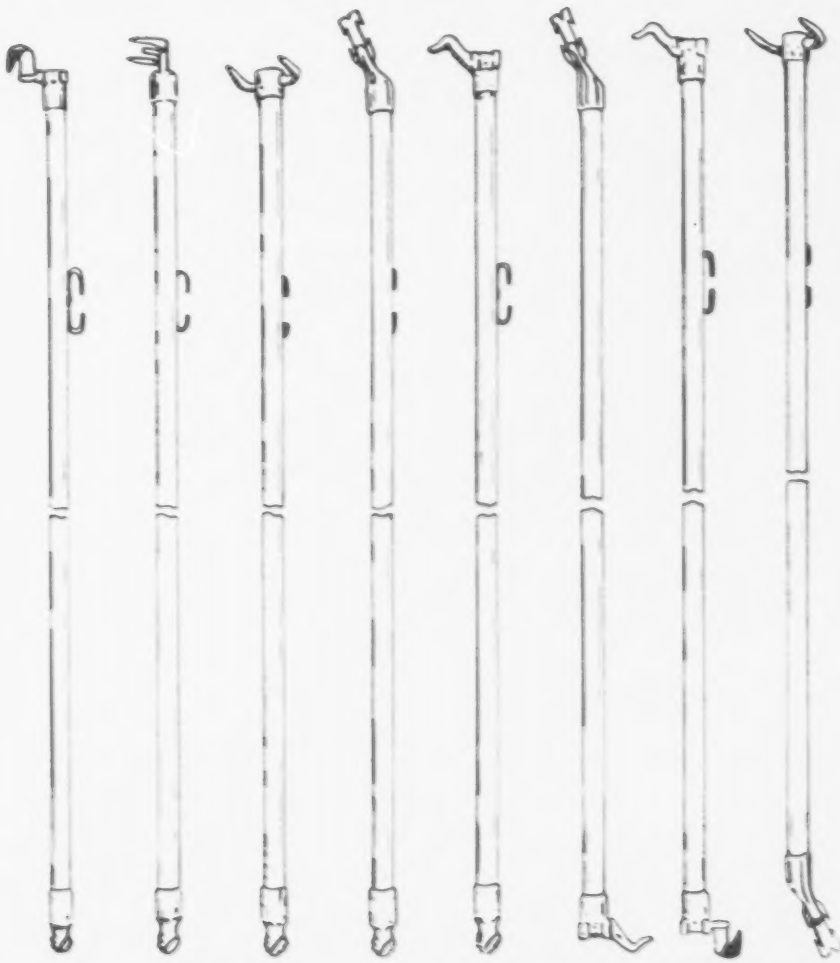
(NOTE: Wire tongs are sometimes referred to as *lift stocks* or *holding sticks*.)

INFORMATION SHEET

- Wire tong saddle — Secures to pole and holds wire tong



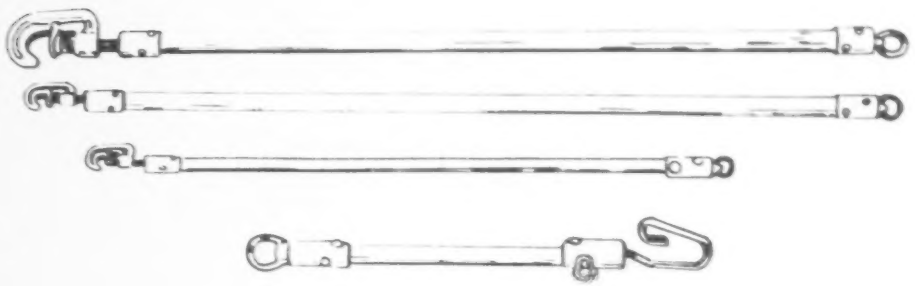
- Tie stick — Unties and ties conductor



INFORMATION SHEET

- Wire cutter — Cuts energized conductor and tie wire

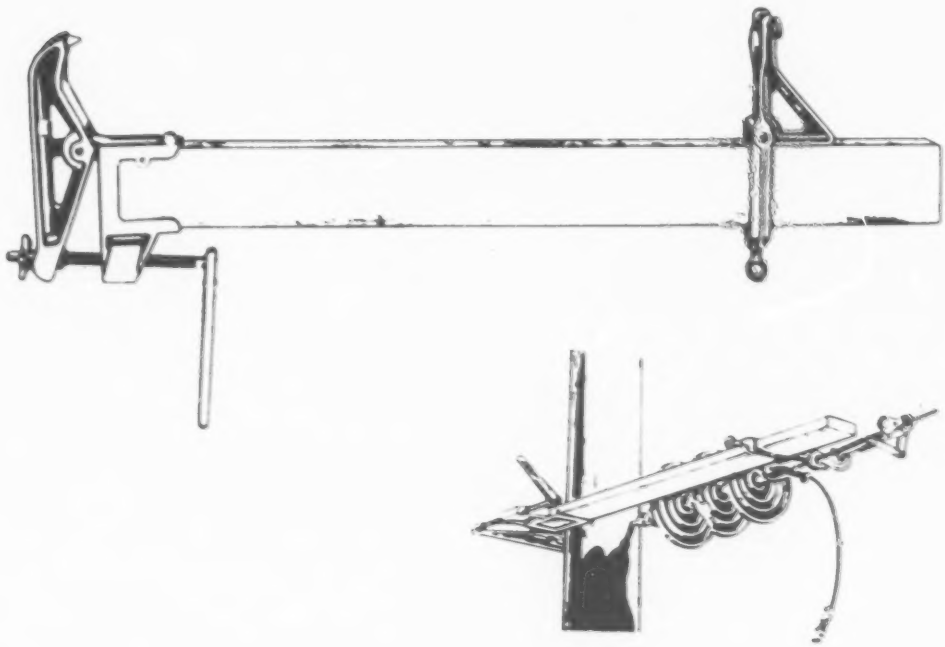
- Link stick — Holds conductors aside when pole is being relocated



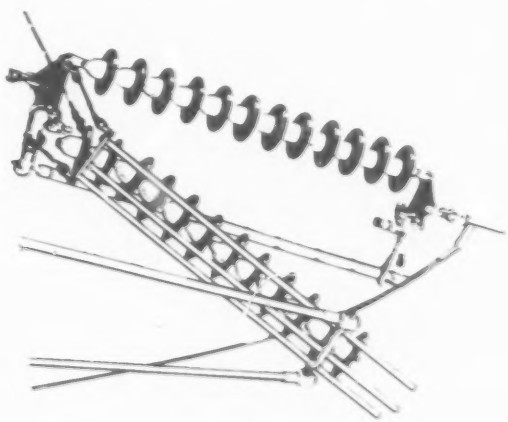
(NOTE: Link stick being used with hot line grip.)

INFORMATION SHEET

- Rural strain carrier — Supports conductor while suspension insulators are being changed

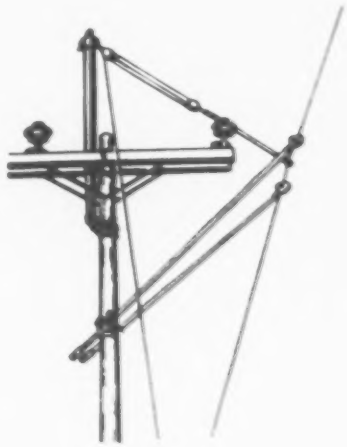


- Insulator cradle — Lowers and raises insulator string



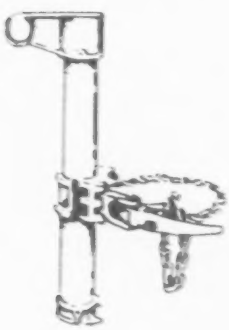
INFORMATION SHEET

- Pole gin — Extends a pole to lay out conductor



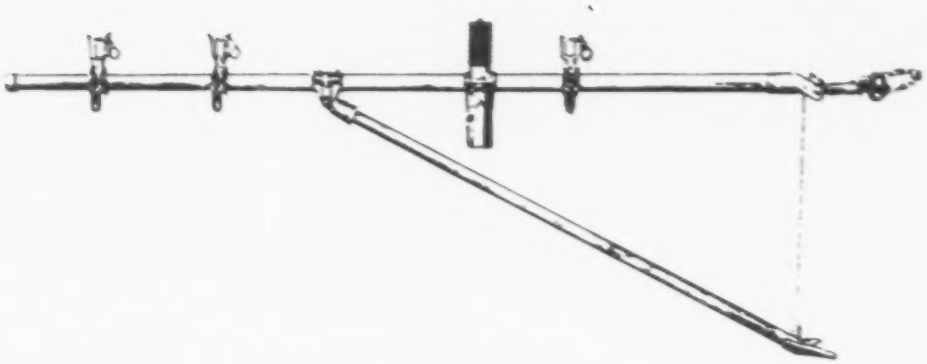
- Transformer gin — Attachment point for rope blocks to raise and lower transformer

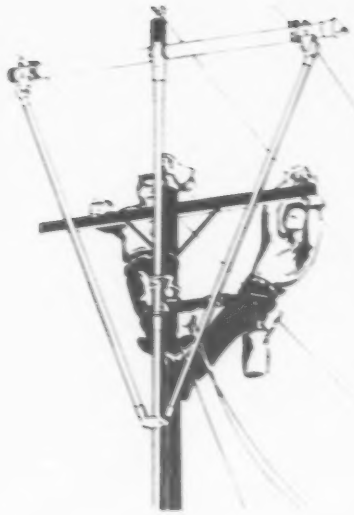
(NOTE: If chain on transformer gin has a keeper key in the end of the chain, be sure to use it.)



INFORMATION SHEET

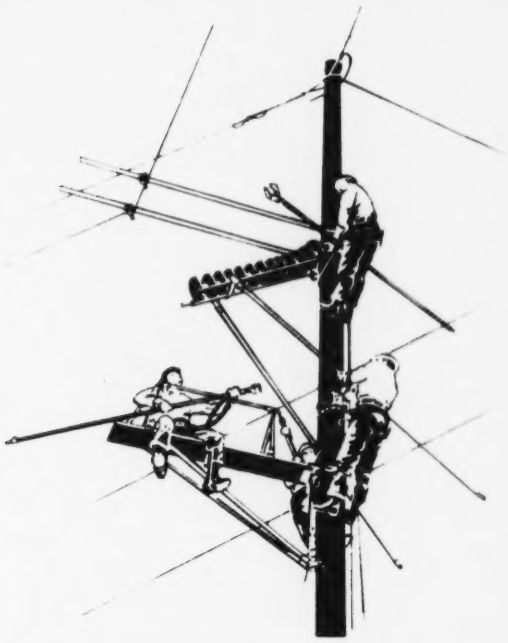
- Auxiliary arm — Holds conductors out of the way of repairs or is used to raise conductors above work area





INFORMATION SHEET

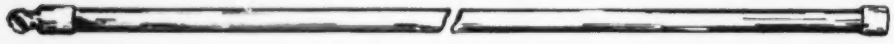
- Universal platform — Supports line technician near work area



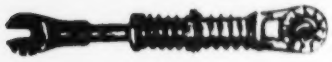
- Hook ladder — Supports the line technician so the conductor may be reached with wire tong or other hot stick

INFORMATION SHEET

- Universal hot stick — Attaches to various tools which enable the line technician to tighten or remove clamps, connectors, bolts, and cotter keys



Universal hot stick

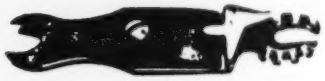


Knocker

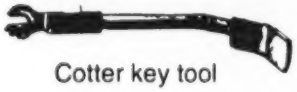
Ball-socket adjuster

Cotter key tool

Cotter key tool

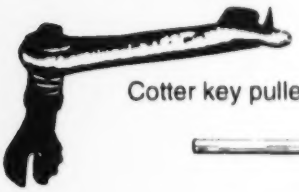


Bolt holder



Cotter key tool

Adjustable insulator fork



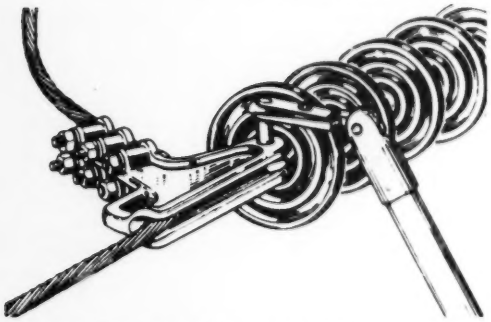
Cotter key puller

Cotter key holder

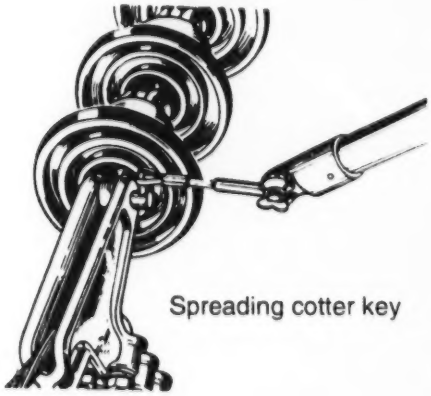
Cog wrench

Cotter key remover

Clevis pin installer



Inserting clevis pin with bolt holder tool



Spreading cotter key

WORK PROCEDURES
(HOT LINE, BASKET, HOT STICK)
UNIT 3

JOB SHEET 1

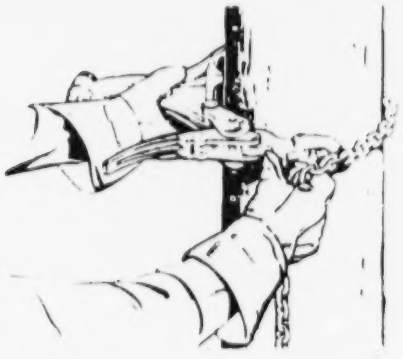
OBJECTIVE 8 — INSTALL A WIRE TONG SADDLE.

1. Tools and equipment

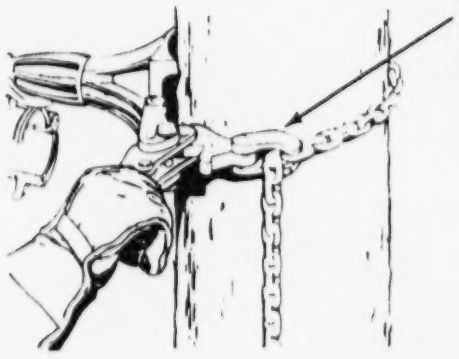
   - Pole, 10 to 12 feet in height
   - Wire tong saddle

2. Procedure

   - Hold saddle in place with chain around the pole



   - Hook chain into securing lever hook and push securing lever toward the pole



(NOTE: If chain has keeper key in the end of the chain, be sure to use it.)

WORK PROCEDURES
(HOT LINE, BASKET, HOT STICK)
UNIT 3

JOB SHEET 2

OBJECTIVE 9 — CHANGE AN INSULATOR ON AN ENERGIZED CONDUCTOR USING HOT LINE TOOLS ON AN A1 STRUCTURE.

1. Tools and materials

   - Handline
   - Rope blocks
   - Tie stick
   - Wire cutter
   - Wire tong
   - Wire tong extension
   - Wire tong saddles, 2
   - Pole top insulator
   - Tie wire

2. Procedure

   - Disengage and lower the neutral

JOB SHEET 2

- Untie one side of tie wire with tie stick

  (NOTE: Check the tie wire on both sides of the insulator to be sure the tie is not broken before the conductor is untied.)

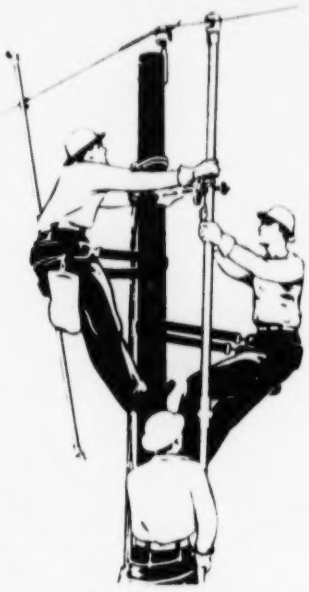
- Install two wire tong saddles

  1. Install top saddle near the neutral position
  2. Install bottom saddle four feet from bottom of wire tong

     (NOTE: Keep ends of tie wire clear of hardware and pole.)

JOB SHEET 2

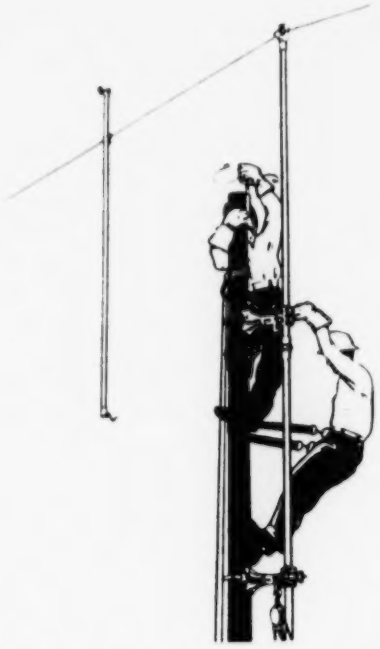
- Install wire tong and secure to tong saddles by tightening clamps on the saddles



- Remove the remaining side of the tie wire

JOB SHEET 2

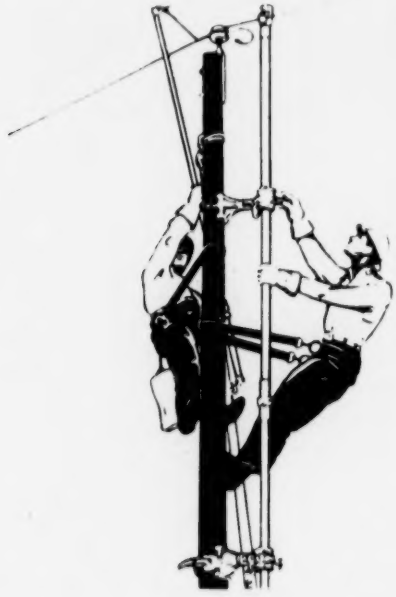
- Raise the conductor with the wire tong and rope blocks attached to bottom saddle and to bottom end of wire tong; tighten saddle clamps onto wire tong



- Remove old insulator and replace with new insulator with hot line tie attached; align the insulator groove with the conductor
- Lower the conductor to the groove of the insulator and tighten the saddle clamps

JOB SHEET 2

- Wrap hot line tie onto conductor on the side opposite wire tong



- Remove wire tong and saddles and complete the hot line tie

- Replace the neutral

TROUBLESHOOTING
(SECONDARY)
UNIT 4

UNIT OBJECTIVE

After completion of this unit, the student should be able to safely follow a procedure for troubleshooting and match various malfunctions to their causes. This knowledge will be evidenced by scoring 85 percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with troubleshooting to the correct definitions.
2. Match indications of malfunctions to the possible causes.
3. Arrange in order the correct procedure for troubleshooting electrical equipment.
4. List precautions to observe when troubleshooting electrical equipment.
5. Select from a list items of information to obtain while troubleshooting.

TROUBLESHOOTING
(SECONDARY)
UNIT 4

INFORMATION SHEET

1. Match terms associated with troubleshooting to the correct definitions.

   - Single phasing — Loss of power on one phase of a three-phase primary or secondary circuit

     (NOTE: Beware of backfeed.)

   - Voltage fluctuation — Extreme swing in voltage above and below voltage base
   - Common phases — Two phases that become energized from a single-phase source
   - Eddy current — Current induced in and around a transformer core or a conductor where it causes heating; current which flows contrary to the main current flow
   - Interlock — Electrical unit that prevents simultaneous operation of equipment
   - Operation — Function of a switch or circuit breaker
   - Relay — Electrically operated device that opens and closes a circuit
   - Trip — Function of a piece of equipment to open a circuit

2. Match indications of malfunctions to the possible causes.

   - Low voltage

     1. Transformer too small
     2. Service conductor too small
     3. Increased load on consumer's premises
     4. Distance to power source too great
     5. Voltage regulator inoperative
     6. Line capacitors out of service

INFORMATION SHEET

- High voltage
  1. Transformer tap set too high
  2. Transformer winding damaged
  3. Voltage regulator inoperative
  4. High capacitance on primary line
  5. Open neutral on secondary
  6. Open ground on transformer tank
- Blinking lights
  1. Poor connection at transformer
  2. Poor connection in meter base
  3. Improper connector on service wire
  4. Meter lugs burned or bent
  5. Trees in secondary or service
- Potential on water pipes or appliances
  1. Open neutral on secondary
  2. Grounds not interconnected
  3. Faulted motor winding
  4. Faulted fluorescent ballast
  5. Equipment or appliances not grounded
- Frequent service breaker tripping
  1. Breaker overloaded
  2. Poor connection at breaker terminals
  3. Breaker contacts burned
  4. Fault on circuit with high resistance to ground

INFORMATION SHEET

3. Arrange in order the correct procedure for troubleshooting electrical equipment.

   - Obtain all information available about the problem

     (NOTE: Check with other consumers to see if problem is on primary line.)

   - Check voltage, amperage, transformer size, and service size
   - Discuss findings with consumer
   - Make repairs or corrections if problem is not on consumer's side of the meter

     (NOTE: Some organizations do not make repairs or work on the consumer's side of the meter because of the liability involved when work is done on equipment not owned by the organization.)

   - Make report on findings and action taken

4. List precautions to observe when troubleshooting electrical equipment.

   - Wear protective equipment
   - Assume that conductors and equipment are energized
   - Use proper test equipment

5. Select from a list items of information to obtain while troubleshooting.

   - Consumer's name
   - Consumer's location
   - Consumer's complaint
   - Number of consumers affected by problem
   - Time and date trouble began
   - Circumstances which might have caused problem

     Examples: Wind, lightning, added load

A CIMC "RAINBOW PROGRAM"

FOR STANDARDS OF TEACHING EXCELLENCE

One very important factor contributing to higher student performance is the expectation of parents and teachers. Experience suggests that teachers and parents who expect student success find that students perform better, attend class more regularly, have positive attitudes, and stay in school longer. The students' success and confidence in their ability to learn may cause additional growth and behaviors that exert a positive influence throughout life.

STUDENT'S PROMISE

Let it be publicly known that students in this program have high expectations of achievement.

I recognize that America's future is dependent on my success in school.
I will attend school regularly.
I will keep regular study hours at home.
I will read each day at home.
I will never accept failure.
I will accept responsibility for my school challenges.
I will respect the rights and feelings of others at home, school, and work.
I will develop positive qualities in myself that my friends will admire.
If I have difficulty, I will insist on help with my school work.
If I have difficulty, I will always try harder.
I will ask my teacher for clear learning objectives.
I will practice good citizenship skills at home, school, and work.
I will keep my parents/guardians informed daily about my school activities.
I will develop goals for school, home, and work.
I will seek advice from my teachers, parents/guardians, and counselors on career guidance.
I will constantly practice the skills of a good student.

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